THE

POPULAR SCIENCE MONTHLY.

JULY, 1894.

THE MEANING OF CORPORATIONS AND TRUSTS.

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TO arrive at an understanding of that tendency toward combination which is a most conspicuous phenomenon of the industrial life of the United States, it is necessary to trace the industrial development throughout its several stages. And as it has been in this country that industrial activity has met with the least hindrance, the steps of its development can be rapidly summarized with approximate accuracy. Although the industrial structures of other countries in previous centuries have had an influence in determining the industrial forms of the United States, the isolation of the American continent and the peculiarity of the conditions affecting its settlement justify the consideration of its industrial expansion as a separate growth, without reference to the industrial status of other countries or older civilizations.

Grandfathers of to-day tell us that in their boyhood in many parts of the country the life of each household was sufficient unto itself. Buildings were erected, grain was raised, winnowed, and ground; cattle were killed, their meat cured and hides tanned; wool was clipped and spun by its members, who, in addition to the performance of manifold other simpler functions, carried processes of manufacture still further—the men, in the days of winter, making the family's shoes and the women its clothes. In doing this work the members of the family were maintaining themselves in that condition which contrasted with barbarism. Houses and clothing were necessary as protection against the often inclement weather, and the possession of a regular supply of food was only possible by the preparation and preservation of the products of the recurring seasons. Upon the evenness of the

temperature of the body, secured by the use of houses and clothing, and the evenness of the vital processes consequent upon regular nutrition, depends that appreciation of the impressions which come through the senses that leads to the clear and vigorous working of the mind. But in those early days tools and appliances were so rude and methods so crude that there was little time for any one to spend except at the work which directly concerned his bodily welfare. The duration of such tasks for men and women was usually from daylight until dark. The self-sufficiency of each household was forced by the conditions of life in a sparsely settled region.

As the number of inhabitants in a certain area increased, and communication between them became less difficult, it was found that the production of certain articles, which involved particular skill, particular training, or particular facilities, could, with profit to an entire community, be left to the individuals possessing the requisite skill, training, or facilities. For example, a man making shoes for a considerable number of people acquired skill enabling him to make better shoes than the man who devoted but limited time to the making of a limited number for his own family, and the greater the time devoted to and the greater the revenue derived from the prosecution of a single industry the more readily could he afford, from time to time, to possess himself of appliances rendering more and better work possible with less effort, and the better could he afford to give more time to seeking the material best adapted for his product, which, as the quantities he used increased, he could secure, other things equal, at decreasing cost. And so with other functions contributing to material welfare.

When the demands upon an artisan became so great that he could not meet them entirely by his own personal exertion he employed a man to assist him. This is the first combination—the simplest industrial organization. Its characteristics should be carefully noted. The efforts of both men being directed by the employer, there is centralized control, and the joint efforts of the two men supplying a greater demand than was possible for the one, the field of their operations extends. And the two men, by systematically combining their efforts, other things being equal, accomplish more than could the two men working separately; wherefore, there is economy of production.

The numbers of individuals engaged in work for which there was greatest demand increased most rapidly—every village possessing its cobblers, carpenters, blacksmiths, and weavers—and with the further increase of population and the extension of the area over which their products or services could be distributed, the number of separate vocations increased. Because of the greater number of people wanting houses it became profitable for

a carpenter to make a specialty of house-building; as furniture was needed, another carpenter devoted his time to making chairs and tables. Likewise the weaver differentiated into the maker of carpets and the maker of cloths for wear; and as the village grew there evolved the tinner, the harness-maker, and so on. The followers of each vocation thrived because the members of the community found it more economical to purchase their better products than to make similar articles themselves. This differentiation or diversification of industries heightened the contrast between the life of the community and barbarism, or, in other words, increased the degree of its civilization because, by reason of the particular skill, training, and facilities of the various individuals who ministered to their various wants, the members of the community became better housed, better clothed, better supplied with the conveniences that contributed to the more rapid and efficient performance of their work and to the comfort of their homes.

The demand for a particular kind of work brought an increase in the number of individuals engaged in that work by causing an established artisan to increase the number of his employees, or by bringing an increasing number of men into that line of industry, some of whom continued to work separately, the direct servants of their patrons, while others formed other organizations of employer and employee or employees. And thus arose competition, members of a community patronizing this or that tradesman or artisan in preference to another as the quality of his work or merchandise, his prices or accessibility, were the more suitable. Competition tended to secure to the members of a community a share of the benefit of the decreasing cost of production, different producers vying with each other to retain or increase their custom either by bettering the quality of their articles or decreasing the price, or both. With increasing ease of communication there was increased competition, artisans, in the course of their work, going more readily from one place to another, and merchantable articles were distributed throughout an extending territory.

With increasing ease of communication and transportation the localization of production was also affected. While many kinds of production remained tolerably evenly diffused over extensive areas, that which depended upon extremely favorable conditions tended to concentrate at localities so favored. For example, in soil especially adapted for grazing, a farmer ceased to plant wheat when he could obtain the wheat more cheaply by purchase from a distant farmer, to whom he could sell the flesh and hides of cattle raised on his meadows. And workmen engaged in preparing the products of cattle tended to concentrate near the grazing regions, while millers would erect their mills near the wheat

fields—all classes profiting by the economy incident to production in the especially favored localities.

With increasing demand for all kinds of products, men of shrewdness to see and ability to grasp larger opportunities enlisted to a greater extent the co-operation of others by the payment of wages or the forming of partnerships. Such co-ordination afforded means for securing in a greater degree the advantages gained by the simpler combinations. For, as the artisan devoting his time to one kind of work tended to acquire the skill, appliances, and the material best adapted thereto; as, under the simplest combination—an organization of two men—these advantages were heightened; he who on a larger scale directed the efforts of others could, by careful training, develop further increase of skill, could because of a larger revenue afford to secure appliances increasing in number and cost, could procure greater quantities of the best adapted material at a decreasing price, and could devote greater energy to multiplying the consumption of his products by increasing their sale in old and extending their use in new markets. And these factors, stimulated by competition, all tend toward economy of production, to the serving of a community increasing both in extent and population with better articles at less expense. Contributing to this result was not only the economy in the immediate production of articles for immediate personal use and consumption, but the economy in the production of material and appliances used in the production of these articles.

With industrial combination and recombination an increase of capital is required for the maintenance of the larger sphere of operation. Such capital necessarily is obtained from the accumulation of those directly in conduct of the operations or from the accumulation of others. The first artisans, as a rule, doubtless obtained by their own exertions the few rude tools and appliances used in their vocations, but in the succeeding combinations funds are contributed by partners, one or more of whom may not be directly or actively engaged in the conduct of the business, in which case the active partner or partners, while benefiting by the use of the contributed capital themselves, also assume a trust, in the ethical sense of the word, for the benefit of the others. Or included in the capital may be the funds of widows and minors, which those in the active conduct of the business therefore hold in trust. When the field of operations so extends as to necessitate plant and appliances more extensive than can be provided except by contributions from the accumulations of a considerable number of persons, there arises a new form of organization—the corporation. The ownership of the various contributions to the capital fund is vouched by certificates of stock. The corporation, therefore, benefits the community as a whole, in that it commands

to a greater degree the factors that tend toward economy of production; in that it directs to greater advantage the efforts of a greater number of workers; in that it permits the attainment of profit upon their accumulations by those that contribute to its capital. As these stockholders may be of all ages and sexes, and oftentimes of residence remote from the scene of operation, those chosen to administer the capital, to conduct the operations, assume a trust of great responsibility. It is essential that control be centralized in their hands; for to the utmost rendering of this trust is necessary the most prudent administration of the capital, the exercise of the greatest discretion in the maintenance, repair, and renewal of the plant and appliances, the most efficient direction of the workers, and the most judicious distribution of the product. These results can not be obtained by scattered responsibility and scattered authority.

It is important to note that along with the development of more comprehensive organizations has been the development of the capacity to control such organizations, men of foresight and executive ability, shrewd and resourceful in the attainment and use of money, oftentimes gaining the control of extended operations over a considerable area that, in their absence, would have been conducted by simpler, separate, and scattered organizations. Not only the opportunity for increased revenue, but the ambition of such men to exercise the power incident to the control of extended organizations, is no small factor in their formation.

The great advance in the bending of physical forces to man's aid that began in the early half of this century has caused so many changes in the methods of production and distribution that it seems as though the industrial processes had undergone a radical transformation. But with the settling of the disturbed elements into definite shape it can be perceived that the seemingly newer forms are but the more compact and comprehensive expression of the old; that they are but successive steps in the series of that development which tends toward the betterment of material, economy of production, extension of distribution, and decrease of cost. The use of steam made possible the railways, in the building and operation of which is necessary the co-operation of large numbers of men working under centralized control, and, in connection with the multiplied uses of machinery, has brought the large factories and mills in which great numbers of men work under control likewise centralized. And the ease and rapidity of communication and transportation afforded by the railroad and telegraph have tended still more to concentrate particular industries in localities where conditions are most favorable to their prosecution. All these factors have allied in cheapening production, in serving a community, increasing both in extent and population,

with better articles at less expense. And they have intensified competition, the railways bringing to a community similar products from factories situated remote from each other, in many instances placing the output of each center of production of certain merchandise in competition in all parts of the United States with the output of each other center of production of that kind of merchandise. Contributing to this result have been the efforts of the salesmen of the different establishments, who, in the desire to extend the sale of their products, have underbid their competitors, who, in turn, have been obliged to lower their prices, this rivalry usually continuing until the selling price has been lowered to and sometimes below the actual cost of production. This competition is beneficial to a community as a whole so long as it compels all the processes of an industry to be conducted with thrift; and it has been beneficial when it has forced at places the cessation of certain production that could not withstand the pressure of competition of similar production from localities more favorably conditioned. But it has been injurious when, after forcing producers in most favored localities to the adoption of every reasonable economy, it has compelled them to dispose of their products at unremunerative prices. It has been injurious when many producers, each striving to dispose of the greatest possible output, have placed upon the market products far in excess of the quantity for which there is a natural and wholesome demand, thereby oftentimes forcing stoppage of production, depriving men of work until the excess is consumed, and oftentimes leading salesmen to persuade unwary merchants to make purchases so large that they are crushed beneath their weight, or tempted to defraud their creditors out of payment therefor. It has been injurious when the strife for the disposition of products has become so fierce that the energies of producers have been absorbed in fighting competition, to the neglect of the orderly and equitable administration of the vital details of production; when it has led them to make misrepresentations as to the quality of their products; when, in the desire to produce cheap articles, it has led to the adulteration of material and scrubby workmanship. It has been injurious when it has reduced the wages of employees to a point inadequate to the support of themselves and their families. Misrepresentation, adulteration, and inferior workmanship have often proceeded from cupidity and lack of scruple, but unrestrained competition feeds their noxious growth.

As with all things else, industrial competition, when carried to the extreme, meets opposing forces that bring reaction, and, as with all things else, the play of mutually opposing forces tends toward equilibrium. Equilibrium between the forces that affect industrial competition is that condition under which industrial

products are sold at prices that are fair to producers and to consumers alike.

When any industry falls into the deplorable condition brought by extreme competition, what recourse is there but for the producers to meet and endeavor to agree upon a course that will permit the attainment of remunerative prices by all; that will lead to the production of only so much output as, according to their combined judgment, can be absorbed without strain to either producer or consumer, to the abandonment of needless and excessive expenditure for solicitation, and to the sale of products only to reputable merchants of sound credit? Such conferences have led to compacts of various kinds, that usually have been but of short duration. The temptation to extend sales by a stealthy cut from the agreed price is too strong to be resisted, and the abandonment of the agreement quickly follows. Then more binding compacts are made—some providing a penalty for the cutting of agreed prices; some providing for a division of territory in which sales can be made by competing establishments; some providing for the distribution of the total sales of a product in certain percentages between different establishments. All such compacts are combinations in a greater or less degree of different establishments, any of which may be owned by an individual, a firm, or a corporation, and, with indefiniteness of meaning, have variously been designated as trusts.

They are, however, but the embryo of the trust properly so called, which is a complete amalgamation of different interests in the same industry. Stock is issued covering an appraised valuation of the several properties to be combined, and distributed in proportion to the owners of these properties, who surrender it to trustees, receiving in return therefor trust certificates issued by these trustees, who become the actual directors of the organization. By such a combination competition between its constituent members is removed. The concentration of management permits economy of administration, the organization, as a whole, obtaining the benefit of appliances and methods that before were peculiar to but one or a few of its constituent elements. The interests of the various producers are placed as a trust in the hands of the men whose mental grasp, practical knowledge, and executive ability enable them to direct to most efficient results the efforts of a great number of workers, to adopt and use to greatest advantage the best appliances, to obtain large quantities of the requisite material upon the most favorable terms, to perceive and meet the conditions of a varying market. And thus it is that the formation of a trust is a uniting of the conditions that permit the attainment in the highest degree of the advantages gained in smaller degree by the first industrial differentiation which marked the beginning

of that diversification which is an accepted sign of progress. The trust succeeds the corporation as the corporation succeeds the firm, as the firm succeeds the individual artisan, as the individual artisan differentiated from the Jack-of-all-trades of the early household.

A trust may be a combination of plants and operations theretofore separately conducted by corporations, corporations and firms, or by corporations, firms, and individuals. Its essential characteristic is the solidification of formerly diverse and opposing interests. This may be obtained by a combination under the trust certificate plan, or by the complete absorption of the ownership of the combining elements. Thus a corporation may be absorbed in a trust which may be transformed into a corporation, which in time may form a constituent element of a greater trust. Under each combination there is increased centralization of control and the extension of the operations in a widening field. And it sometimes happens that one man, or a few men closely associated, hold a controlling interest in, or predominate in the direction of, several organizations. There are two or three firms in New York, for example, any one of which regulates the management of two or more railroad or other corporations.

In each sphere of development, from the growth of the planetary systems out of the nebulous mass to the ascent of the living organisms of highest endowment from the protoplasmic mass of dull and homogeneous sensation, all progress has been along the lines of differentiation of function and structure and co-ordination of like functions in a decreasing number of structures or organizations, each characterized by an increasing centralization of control of a broadening field. If the working of the industrial forces that has led to the formation of corporations and trusts is directly analogous to the working of forces that along other lines has led to analogous effects, this industrial aggregation is a natural and inevitable step of industrial evolution that therefore can not but be beneficent in its final results.

As evolution along any line is most direct when its forces are least impeded, the industrial development of the United States should have been most rapid, for here conditions have been more favorable to industrial activity than among any other people at any time in history. The American settlers were of vigorous ancestry; natural wealth abounds; the climate is temperate; and there has been the least retardation from the evils of government, the evils of war, and religious intolerance. From this is another proof that the formation of trusts is a natural step of industrial evolution, for it is in the United States that they have been of most direct growth and have attained their greatest dimensions and their greatest strength.

It has been remarked, with some show of facetiousness, that from the trust that supplies the cradle wherein he is rocked in infancy to the trust that furnishes the coffin wherein he is laid for the tomb, man is housed, fed, clothed, transported, and entertained by a trust of one description or another. And, notwithstanding arraignment in public print and public speech, trusts thrive and prosper. This alone might lead to the inference that they are the product of natural forces.

But trusts are not in possession of the entire industrial field. Not in any one line of industry is the entire production effected by the agency of any one combination. There are even corporations, firms, and individuals engaged in the production, refining, and distribution of oil that owe no allegiance to the Standard Oil Company. There are refiners independent of the sugar trust, and iron manufacturers that are not in any pool. There are trusts in the same line of industry working in direct competition with each other, and also with firms and individuals engaged in like production. For example, the New York Biscuit Company, the United States Baking Company, and a similar company operating principally west of the Mississippi River, are three different trusts engaged in the manufacture of products of the bakery, operating principally each in territory separate from the other; but at points in the territory of either it is in direct competition with the other, and each, in its own territory, is in competition with firms and individuals supplying bread, biscuits, crackers, and kindred articles of consumption. There are towns and villages not reached by any of these trusts that are supplied by local bakers, and there are thousands of households throughout the land producing almost entirely within their own kitchens all the products of grain consumed by their members. A certain similarity to this condition is presented in each other line of industry throughout the entire field. Combination is most marked in industries requiring expensive plants and appliances and the services of a large number of especially trained workers in preparing a product for which there is great and constant demand, the railways and iron and steel and the textile industries all affording conspicuous examples of strong combination. In the more densely populated portions of the country there is combination to a greater or less extent in other industries that, in more recently settled portions of the country, are administered by smaller organizations, the three baking companies being notable examples. A variety of causes, more or less general, more or less particular, have affected combination in the different lines of industry at different places. The general tendency, however, is toward the formation of separate organizations for the manufacture of an increasing variety of specialized products, and toward the combination of the com-

paratively similar organizations concerned in the manufacture of each particular product into a decreasing number of organizations characterized by increased centralization of control and the extension of their operations in a widening field. This tendency is in exact accord with the law of evolution as defined by Herbert Spencer, and the heterogeneous aspect presented by the different coexistent degrees of combination in the industrial field analogous to the heterogeneous aspect presented by the various coexistent stages of development in each sphere of evolution throughout the universe, all phenomena of which are now believed by the deepest thinkers to proceed in accordance with that law.

It is true, however, that in the processes of this industrial development are phases affecting adversely the fortunes of classes and individuals, although working to the benefit of the community as a whole, and there have been phases entailing actual oppression without other attendant good than the bestowal of experience.

The displacement of human labor by machinery and improved economical methods has been the cause of much outcry from those whose earnings have been immediately affected; but that readjustment to meet the advanced conditions can not but be beneficial to society as a whole perhaps needs at this time no extended defense, and likewise with the displacement of labor caused by the cessation of industries at particular places under stress of competition of more favored localities.

In the first reaction from the unremunerative prices forced by competition, a combination sufficiently powerful to do so often raises prices of a product to a point as unreasonably high as previous prices were unreasonably low, and this is the basis for one of the apparently potent arguments against the toleration of trusts—that they are oppressive to consumers. But there is the reply, first, that the desire to obtain the increased profits consequent upon an extending sale of the products will cause the most enlightened managers to keep their selling prices at the lowest point that consistent with profitable production will to the greatest extent increase consumption. When, however, this consideration does not prevail, there is a further check upon the maintenance of exorbitant prices in that capital, which tends to flow into the field in which greatest profits can be made, reduces prices by engendering new competition. Delay in the action of this corrective frequently has been caused by the fact that the making of enormous profits for a time is kept secret oftentimes by a combination engaged in an industry requiring a plant for its operations so extensive that great capital and experienced managers are necessary to establish successful competition; and the de-

lay has been longest when, along with these conditions, the product has been of such a nature that the payment therefor ultimately comes from those not concerned in its immediate purchase. But it is a fact that in the industrial history of the last quarter century, notwithstanding these obstacles, many a combination strongly fortified in the maintenance of undue profit has, sooner or later, had its power broken by the flow of new capital into its field.

In the manufacture of steel beams and steel rails are required plants of great value, and the services of experienced managers and skilled workmen. The charge for beams falls upon the renters of apartments in buildings of the construction of which the beams are part, and the charge for rails upon the travelers and shippers over the railways; and, as the immediate purchasers of the greatest quantities of beams and rails are often, if not generally, not the direct owners of the property for which the purchases are made, and therefore neither the immediate nor the remote payment comes from the pockets of the immediate purchaser, the action of competition in effecting a reduction in the prices of such material has been subjected to extreme delay, but that it finally effects such a reduction is shown by the fact that whereas seven or eight years ago the beam combination was composed of but five establishments who obtained over three cents a pound for their product, there are now over a dozen establishments engaged in this manufacture, and the price obtained is about one and a half cent per pound, and likewise combination after combination of steel rail producers that have endeavored to maintain unreasonably high prices has been broken.

Another corrective of the maintenance of inordinately high prices lies in the fact that a combination making one product upon an extensive scale is prone to discover means whereby waste, incident to that production, which could not be utilized by the smaller producer, can be made a valuable article of commerce, and the combination, therefore, has found it to its interest to stimulate the consumption of its principal product by reducing prices, in order that it may obtain the additional profit consequent upon the increased production and sale of the subsidiary product. For example, when a dressed-beef concern of Chicago found that oleo oil could be made from the inside fat of cattle, it reduced the price of beef to a narrow margin of profit, that it might increase the sale thereof and thereby obtain the increased supply of fat for the production of oleo oil, for which there is great demand. Other dressed-beef producers were forced to reduce the prices of meat accordingly, the result being of great benefit to the consumers of meat, who are practically the entire population.

It has also happened that the maintenance of inordinately high

prices for a particular product has led to the discovery of means whereby another product can be used in its stead, whereby the manufacturers of the original product have been compelled either to reduce their prices or retire from the field.

Competition, before reaching the point where the leaders in a particular industry are forced into final combination, tends to lower the wages of laborers in that industry; for, as it is to the interest of the consumer to procure that which he needs at the lowest cost, his efforts to buy cheaper tend to force the cost of production to the lowest notch. When this pressure for low prices is such that it can not be met by the saving in production gained by the use of economical methods and improved appliances, attack is necessarily made upon the wages of the workmen. Likewise the efforts of the salesmen of a particular product to extend its market in competition with other producers, force the lowest cost of production with like results upon the wages of the workingman. After competition has forced the final combination, the wages of workingmen in but few instances have voluntarily been increased, and sometimes they have been reduced. Those in control of the capital, desiring to recoup for past losses and to secure the greatest returns for the future, still find it to their interest to keep down the cost of production. From this has arisen the cry that a main purpose of industrial aggregation is to crush the workingmen. To retain their employees, however, even great combinations are usually obliged to pay wages not less than can be obtained in other fields. Such combinations must be managed by men of the first ability, whose services can not be secured except for high remuneration. To the efficiency of their work is necessary the careful training of a corps of subordinates to whom it is to the interest of the corporation to give adequate remuneration and certain tenure of position so long as they remain competent. And even to laborers of the lowest grades these corporations must pay a rate of wages established by supply and demand. It is shown by statistics that the rate of wages during the past fifty years has steadily increased, in all except the vocations that are being supplanted and are dying out. The rate of wages is a matter, however, in which self-interest on either side is the principal factor, and, whether forced by competition or actuated entirely by selfishness, employers, as a rule, have not at any time extended any greater compensation to their employees than they have been obliged to. But in opposition to the tendency to force wages down there have also grown combinations, the labor organizations. These are trusts, in that the laborers in a certain field of industry place the care of their collective interests as a trust in the hands of the officers thereof. The theoretical justification for the existence of labor organizations is, therefore, the same as the

theoretical justification for the existence of our democratic form of government—that is, that the best interests of the constituent individuals are best served by placing in the hands of their chosen representatives certain functions which can be better performed for the individuals by those representatives than they could be performed by the individuals for themselves.

When an employer announces a rate of wages, an employee has the right to work at that rate or not, as he may choose—that is, he has the right to contract for his services. But if the manager of a mill, a mine, a factory, or other large establishment employing a great number of workmen engaged in the same kind of work, announces a reduction from the established rate of wages, what is the effect upon the individual workman if entirely dependent upon his individual resources in the negotiations incident to this individual contract? He may continue to work at the reduced wages or not, as he may choose, but to seek work at another establishment is often impracticable, especially if necessitating removal to another locality. To remain without work, even for a short time, entails ill-borne loss. The result is that a portion of the employees may leave, but the majority find it preferable to accept the reduction, especially those who have acquired homes in the vicinity, and live wrapped in the web of attachment woven by the associations of the home, the neighborhood, and the community. The contract for a rate of wages between the employer and the individual is, therefore, one in the negotiations for which the employer has an advantage so tremendous that his decision is practically the mandate of a despot, and, as upon the rate of wages practically depends the employee's subsistence, the amount of necessaries, comforts, and luxuries he can procure for himself and family, the employer oftentimes has greater power over the manner of life and the happiness of his employees than the Constitution accords to Congress and the President of the United States. When this power is used to reduce wages, workingmen have frequently but little means of knowing whether the reduction is forced by the conditions of production and distribution, or whether it is an arbitrary attempt to swell the employer's profits. The conditions of their lives are such that they can not know much of the cost of plants, appliances, material, and the relation that wages bear to the cost of production or to the expense of distribution. In any event, the strong promptings of immediate self-interest impel them not only to resist any reduction, but to endeavor to obtain, from time to time, an increase of wages, a general betterment of condition; and as individual assertion is of little or no avail in resisting reduction or obtaining an increase, the natural result is that the workingmen in a particular line of industry endeavor to obtain by combined action that which they

can not obtain separately, and thus have arisen organizations of the workingmen in different lines of industry, and as they have increased in number and complexity, they have tended toward more extensive combination, with greater centralization of control—witness the Knights of Labor, the Sovereigns of Industry, and the American Federation of Labor. But as the representatives of the people, charged with the administration of the political government, have, times without number, because of ignorance of the working of economic law, because of cowardice in following their convictions, because of personal greed, because of a truckling to popular prejudice, enacted laws, sanctioned executive action, or indulged executive neglect, that have inured to the injury of the people as a whole, so also have the representatives of workingmen, charged with the administration of labor organizations, from like causes, enacted regulations, permitted action, or neglected to restrain action, that has worked to the direct injury of their constituents, and tended to bring labor organizations, as a class, into widespread obloquy. As the demagogue has often obtained political preferment, so also have the palavering hypocrite and the sordid bully but too frequently been made the representative and spokesman of labor; and then, again, it has often happened that well-meaning representatives of labor, after conferences with employers in which they have been clearly shown the conditions that necessitate reduction of wages, or that render impossible an increase of wages, have been repudiated and condemned by their constituents when endeavoring to make such conditions clear to them. All too often have workingmen of the best intentions been overruled by the headstrong, who have worked upon their credulity and prejudice until they have met appeals to reason with unreasoning sullenness, and when minds credulous and prejudiced have been inflamed by liquor there have been deplorable and disastrous results. In years past the conferences between the representatives of capital and the representatives of labor have too often been marked on both sides by aggressiveness, rapacity, and greed, by the absence of good faith and calm, considerate, thorough discussion. Strikes have inured to the injury of both capital and labor, but as strike after strike is fought and ended the reasons for the conflicts come more clearly to the light of publicity, and popular opinion, the basis of all law, seizing upon the points of dispute and perceiving the attitude of the combatants, visits with condemnation or approval the one side or the other; and this light of publicity, searching out that which is unjust in the action of labor and that which is unjust in the action of capital, can not but bring, and may now be seen to be bringing, a healthier tone to the proceeding of one and a greater honesty of consideration to the attitude of the

other, from which can not but come a more reasonable and equitable solution of the problems that are continually presented to each.

And notwithstanding all the attacks that have been made upon them, labor organizations survive. Like the other trusts, they are the product of natural forces; like the other trusts, they fulfill a natural function. As men of greater knowledge and broader views come to their control, the directors of great industrial organizations who want to be just toward their employees find it advantageous to communicate with them through such representatives. The situation can be gone over with them more frankly and thoroughly and in shorter time than would be possible with each of the workingmen separately, or with all of them jointly, and the report and recommendations of these representatives to the workingmen can be met and received as the result of the best judgment of competent minds acting in their behalf. It is to be hoped that in time the perception of a common interest and a common sense of justice between employer and employee will render the labor organizations unnecessary. It is likewise to be hoped that advancing civilization will reach a plane whereon all political government will be unnecessary.

An assertion that has been used with great vehemence against industrial aggregations is that they are instruments for ensnaring and misappropriating the funds of the weak and unwary. Condemnation on this ground was made of the minor industrial and financial combinations. The cry against corporations a generation ago was as bitter as that against the trusts of the present. It has arisen from the fact that the multiplicity of means that have been developed for borrowing capital, the giving of mortgages, the issue of stock certificates and bonds of different kinds and forms, with the attendant manipulation in stock markets, has given men with predominating desire for personal gain opportunity for obtaining money in excess of the needs of their business, or of the value of the property which they can offer as security, and complicated methods of bookkeeping have concealed its unjustifiable application and the misuse of profits. Instances of such defection have been so numerous as to breed in the minds of a considerable portion of the population a certain distrust of all that pertains to the buying and selling of stocks and bonds, and this distrust in many places with many people is so deeply rooted that the advantages to the entire community gained by honestly and discreetly managed industrial combinations are overlooked. It is the men of largest brains and keenest wit that in the fields of finance and industry conceive and control enterprises of magnitude, and when this keenness of wit has been combined with lack of scruple they have often been able to envelop the conduct of their enterprises

in a mystery that the ordinary mind did not penetrate, under the cloud of which they have wrested undue personal gain. The conversion by men to their personal ownership of funds and estates held by them as trustees was an abuse from which the common law for centuries was inadequate to afford immunity. The development of the ethical trust relation sustained by those in active conduct of the great industrial organizations of this century to those whose funds are invested therein has been more rapid than the development of the legal safeguards for the protection of that relation. But as every abuse is the forerunner and the cause of its own remedy, the deleterious manipulation of stocks, bonds, and securities of every sort must give way before a public intelligence that tends more and more to a perception of the methods by which it has been possible. And this intelligence will compel the embodiment in legal codes of measures that will place these recently developed trusteeships upon as clearly defined and safe a basis as the earlier and simpler trusteeships were placed by the system of jurisprudence and jurisdiction organized by the Earl of Nottingham.

It is frequently asserted that a nation's industries are in most healthful condition when conducted by a great number of independent producers. If carried to its logical conclusion, this implies that the village artisan who employs one man to assist him is guilty of an act of injustice. For otherwise, if A has a right to better his condition by working for wages under the direction of B, why should not both A and B, if they can better their condition by doing so, work for wages under the direction of C? And why should not scores and hundreds of men work under the direction of the master mind of Z? It is true that whether impelled by the desire to obtain increased profits, or by the constant demand for the reduction of prices, it is the tendency of an industrial combination to absorb the performance of the functions contributing to the manufacture of its ultimate product, thereby either destroying or curtailing the profits of those theretofore engaged in the performance of those functions. For example, but a few years ago the placing in the Northwestern markets of coal from the Pittsburg bituminous coal field involved the making of profits by the mine producing coal, the agent in Pittsburg that purchased it on commission, the firm who employed him, the company over whose docks it was loaded in vessels at the ports of Lake Erie, the owners of the vessels which carried it to the Northwest, the owners of the docks on which it was unloaded at the head of the lakes, and the dealers who disposed of it in the various Northwestern cities. The pressure of competition reducing the possibility of separate profits has forced the combination of these different agencies of production and distribution—for in-

stance, one man now controls what is practically one organization, owning mines at Pittsburg, docks on Lake Erie, vessels that ply on the lakes, docks at the head of the lakes, and coal yards at St. Paul and Minneapolis. As the retail price for Pittsburg bituminous coal at St. Paul and Minneapolis has been materially reduced in the past ten years, it will be observed that the coordination of the various functions enumerated has resulted in immense benefit to the consumers of coal, that has extended throughout the Northwestern States. When contributory functions are absorbed by a combination, the men engaged in the performance of those functions are not deprived of a livelihood. Their services are needed in the performance of those same functions by the combination, which must yield them compensation in accordance with their experience and ability. If it be the effect of this competition to force a lesser income than accrued from the profits theretofore enjoyed, the result, while it may to a greater or less extent be to the misfortune of the absorbed individuals, is for the good of the community as a whole. If the functions which they did perform can be performed by the combination equally well at less expense, it would be unjust to the consumers of the ultimate product for these individuals to continue to enjoy such profits. There is the further consideration that in the performance of the various functions necessary to the continuation of a great organization men of various kinds of ability can devote their energies to the tasks for which they are best adapted. The organization and the nation as a whole are therefore benefited by having the best outcome of men who, if working independently in a smaller sphere, would be hampered by having to give a greater or less proportion of their time to tasks for which they are less adapted.

The instinct of self-preservation, carried to its extreme in the desire for the greatest gain with the least liability for aggression, is apparent in the different steps of industrial combination. The limited partnership laws in effect in many of the States contain provisions restricting liability that, as a rule, have stood the test of application, but there has been much irregularity on the part of corporations that, obtaining a charter under the laws of a particular State, have gained advantages that have permitted operations in other States under the laws of which similar privileges could not have been obtained; and, conversely, particular States have placed unjust restrictions upon the operation within their jurisdiction of corporations working under charters obtained in other States. The desire to evade responsibility, together with the desire to evade the assault that in many localities is facilitated by the laws arising from distrust of corporate action, has led certain of the combinations known as trusts to adopt carefully

studied and elaborate plans of organization that permit the greatest freedom of operation, while reducing to a minimum the opportunity for legal attack. Such devices, to the extent that they exceed the bounds required for proper self-protection, can not long stand before an increasing intelligence of their aims and methods. That same intelligence, acting through the media of courts and legislatures, must arrive at a more equitable solution of the problem of corporate rights and corporate aggression.

In the effort to extend to the greatest degree the sale of its products, a trust now and then has adopted other measures than the endeavor to place upon the market products of a quality and price that will insure the largest consumption. In certain localities it has, regardless of immediate loss, placed the selling prices of its product at a point so low that a competitor can not meet them without loss that, if continued, will drive him from the field. But it has happened that the resources of a competitor, or his facilities for production, have been such that he can successfully defy such an onslaught. In such a case a trust has sometimes adopted another method of attack by coercing merchants into desisting from the sale of the competitor's products under threat of using the influence of the trust to harass and embarrass them. Such methods, although sometimes apparently successful, often redound to the injury of the user, for one of the first steps of the object of the persecution is to enlist sympathy by giving publicity to his position. When, however, an industrial organization gives a merchant who agrees to sell its products to the exclusion of similar products of other manufacturers lower prices than if he also handled competitors' goods, it is simply acting upon the established principle of selling greater quantities at lower prices than lesser quantities. If these low prices yield a profit to the producer, and the products can be sold by the merchants at a lower price than similar products of competing producers, the result is that consumers are benefited by the reduced prices, and the profits of the merchants and manufacturers are increased by reason of the extended consumption.

An organization controlling the shipment of large quantities of material used in manufacture, or of a finished product, has oftentimes been able to obtain lower rates of transportation than its competitors because transportation companies have underbid each other in the desire to obtain the extensive traffic, and the advantage gained by means of the low rates has contributed to the exclusion of competition. Many of the States have established commissions to look into the administration of transportation companies, and the Interstate Commerce Act was the beginning of national action in the same field. And the State and national commissions are throwing light on the problems of trans-

portation that have been but little understood. Abuses are being corrected, and in many instances procedure supposed to be to the injury of the public in general is shown to flow from the action of natural forces tending to the public good.

Much that has been evil in the conduct of trusts has been ascribed to the working of our so-called protective tariff, and the exclusion of foreign competition has, doubtless, been an important factor in the over-capitalization of different plants and the watering of stock that have been almost constant elements in trust formation. But it is not to be inferred that an abandonment of or a reduction in the tariff would be followed by the dissolution of trusts. If the greatest economy of production is obtained under a trust, which is the final combination forced by competition, will not the renewed and intensified competition consequent upon an abandonment of or a reduction in the tariff render the trust all the more necessary? The foreign competition will doubtless hasten a reduction of undue profits, but at the same time will tend to increase the compactness of organization and method under which the final industrial combination is of greatest good to the community. The three baking companies referred to on a preceding page are examples of trusts the formation and continuance of which do not depend upon any advantages derived from the tariff. The United States Baking Company was formed under the pressure of competition entirely domestic. It thrives because the operations of the constituent baking establishments are conducted under centralized control, by which is obtained for each the advantages of the best appliances and methods, the best adapted material at the lowest cost, and the most judicious distribution of the products.

As it often happens that the actions of a servant, performing his duties quietly and efficiently to the increasing satisfaction of his master, meet with no other recognition than the stipulated compensation, although departure from the exact line of correct performance, whether apparent or actual, whether the result of ignorance, carelessness, or positive dishonesty, meets with complaint, rebuke, and punishment, so it has happened that an industrial combination which is but the servant of the public, so long as its operations have been confined to the production and marketing of articles for which there is a demand, of a quality and at prices that satisfy that demand, has been permitted to continue its functions without particular attention, receiving reward in the profits accruing from the sale of its product. But the real or apparent departure of such an organization from the simple performance of such functions, whether the result of actual aggression or the disturbance entailed by the readjustment to changing conditions, brings outcry that has been followed by that public

rebuke which has ended in legislative enactment designed to prevent a continuance of the real or apparent abuse. The discharge of employees, the reduction of wages, the raising of prices, the decrease of production, whether justifiable or not, antagonize the immediate interests of a greater or less proportion of the population whose discontent often finds voice through men who, whether sincere or guided by self-interest in their protestations, are utterly unable to trace the ramifications of cause and effect throughout the complications of the industrial and commercial web. And such men, clothed with the power of legal enactment, have given force to statutes that have tended to kill instead of to cure. But it can not be denied that the desire for gain, without due regard for justice, has led men charged with the administration of industrial organizations into actions that have abundantly justified public complaint and severe punishment, and many organizations have been formed because of the facility for public aggression attained by combined action and the absence of individual responsibility; and all that has been reprehensible in the acts of such organizations, gaining a greater or less publicity, has tended to obscure the perception of the benefits of industrial combination as a whole.

The enumeration of the evils attendant upon combined action leads to the perception that they did not spring into existence at any one period of industrial development, but that they are the outgrowth of not properly restrained actions, arising from motives that exist in individuals, and were manifested in the actions of individuals before the tendency toward combination became noticeable, and have been manifested with increasing conspicuity at each of the stages of combination. In other words, the vices and virtues of aggregations of men are but the vices and virtues of individual men, and vice and virtue alike become intensified as they are manifested in the actions of an aggregation of men controlled by leaders of whom they are characteristic. Opportunity for dispute as to the rate of wages and the hours of labor arose when there were first employer and employee. It is the very trading instinct to sell at the highest price and purchase at the lowest. The mean and the crafty have ever sought to obtain money without repaying it, to obtain privilege without compensation, to gain advantage over others by fair means or foul. As it has been the increase of intelligence and morality and accumulated experience that has led to a wider justice between individual men, so must it be the increase of intelligence, morality, and accumulated experience that will lead to the allotment of justice between individual man and an aggregation of men, and between aggregation and aggregation.

The very hugeness of the more recent industrial combinations

has raised in the minds of many a vague fear akin to that which children feel when they read of giants and genii, and politicians have conjured with their names as nurses frighten infants with tales of great monsters that are coming to eat them, and this notwithstanding that the greatest effect in all fields of human effort has been gained through organizations, characterized by combination and recombination, that, working under centralized control, have enlisted great numbers of men in the attainment of far-reaching ends. The advantages of combined action in bodily attack and defense led step by step through the grouping of tribes and clans to the formation of great armies. Upholders of like ecclesiastical doctrines have associated themselves in organizations that have sought to extend their sway by united effort. Similar needs of similarly conditioned masses of men have caused the growth of political governments that have combined and recombined. With advancing civilization the soldier's calling becomes of less and less importance; with the growth of the intellect ecclesiasticism loses its dominance; and with the loosening of the shackles of paternalism the sphere of political government recedes. Advancing humanity now demands, more than ever before, the service of him who contributes most to that wholesome care of the physical being which is essential to the highest development of the mental and moral life. The artisan and the tradesman, who were the butt of ridicule, the object of contumely, when my lords the warriors and my lords the bishops ruled the world, find that their vocations, increased and extended by the aid of science, are of inestimable value to the human race. The forces tending toward the highest civilization, that through physical conflict have evolved the great nations which abide side by side under a fuller promise of peace—that throughout the strife between mind and mind as to the Unknown Cause have evolved the great religious organizations that seem more and more content to abandon useless dogmas, to join in the promulgation of moral precepts that are common to them all and in the ever more discreet ministration of charity—are now swirling with greatest intensity in the field of industry, evolving the great industrial organizations, that through the mutual reaction of one upon the other will bring that clearer knowledge by means of which they will be made the peaceful and harmonious agents of the higher life. And therefore, inseparable from consideration of the causes that have led to industrial combination and the effect of industrial organizations in the present, is speculation as to the direction the tendency toward such combination will take in the future, the extent to which it will involve industrial functions, and the effect the organizations will have upon the individual life of the members of a community.

Functions, the performance of which particularly depends upon the skill and application of individuals and have little connection with concrete production, will likely to a considerable extent remain exempt from combination, although attorneys and physicians whose pursuits depend almost exclusively upon separate individual ability and application have allied themselves in associations through which to an extent fees are regulated and the experience of individuals is brought to the benefit of all. A striking example of the centralization tendency is presented by the action of the banks in many of the larger cities during the recent financial distress. To the clearing house, which is primarily but a combination of banks for mutual benefit, which inures also to the benefit of the public, were assigned securities belonging to each of the banks holding membership therein, to be held by the clearing house as the basis for the issue of clearing-house certificates which were designed for the benefit both of the banks and of the community served by them. As the property of the different banks was placed in the hands of a committee clothed with executive authority, this action displayed a principal characteristic of the trust formation.

Consideration of the effect of industrial organizations upon the individual lives of their members leads to analogy drawn from the relation borne by the individuals thereof to the other great organizations that have attended the progress of humanity. As the true soldiers were content to find their reward and glory in the valorous service of the militant organizations to which they belonged, as the sincere ministers attained the highest personal good by the abandonment of self in the striving to uphold the precepts of their creeds, so it may be that the members of a great industrial army, imbued with the feeling that their well-directed energies contribute in the greatest possible degree to the welfare of the nation, to all that is meant by the attainment of the highest civilization, will find happiness in their work that is only equaled by the happiness found in their homes, and will be content with the personal credit and personal reward that may follow the exercise of their ability in a field where an increasingly juster perception of each man's capacity will give the opportunity for its fullest utilization, and where there is increasing recognition of the fact that it is to the efforts of all the workers in a particular field that results are due, that the credit in proportion to his usefulness belongs to the private as well as to the general. The manager of a great railway gives the best of his mental and physical energy to the conduct of its affairs, with the consciousness that he is thereby contributing to the welfare not only of the corporation and its employees but of the community which it serves; likewise with the president of a bank or the head of a great industrial or-

ganization. The name of the organization he serves may have endured for long before his term of service and for long after, as the name of the nation endures throughout many changes in the head of its government. If a prime minister finds more than pecuniary reward in having risen to the most important place of service to his nation, so should a captain of industry find more than pecuniary reward in having risen to the place of most important service to a great industry that ministers to the welfare of a multitude of people. If a sailor in the navy takes pride in contributing his mite under his nation's flag, so should the industrial private find satisfaction in the thought that his efforts are of use.

Besides the pleasure that he should find in his work, there is the happiness man should find in his home, in wholesome recreation, and the development of his mental and moral nature. That which is essential in the enjoyment of home does not depend upon the place in the industrial world occupied by the head of the family, for that there may be contentment in the cottage and misery in the palace is proverbial. Now that wise managers are discovering that the best work is obtained from men whose life in its entirety is most wholesome, it may be expected that in time the executive heads of great organizations will endeavor to allow their fellow-workmen every reasonable facility for domestic enjoyment, healthful recreation, and self-culture. And all the advantages gained by industrial combinations lead to this end. As products are cheapened their use becomes extended, so that in time it may be expected that the humblest may possess themselves of the clothing, food, and conveniences of habitation that minister in greatest degree to bodily health. As men working in concert with improved appliances and under improved methods produce a greater and greater output in less time and with less nervous and muscular exhaustion, it may be expected that before many generations have passed the labor necessary to supply the material needs of the human race may be encompassed within limits of time and exertion that will allow to all sufficient leisure and sufficient spirit for the cultivation of all that gives to life its perfect flower. The great industrial organizations perform for all the people what the men and women in the days of our grandfathers did for themselves and their families. They extend the mutual helpfulness of all the members of the nation, binding community to community, "obtaining an advantage while conferring a boon"; and the increasing exchange of products between nation and nation gives reason for belief that in generations to come, as the individuals of different nations know and appreciate one another more truly, there may be an extension of industrial organization that will have the whole world for its scope, ministering to all mankind.

A recapitulation and summary of cause and effect throughout the industrial development of the United States as outlined in the foregoing pages lead to the conclusions:

That specialization of function and co-ordination of similar functions become more pronounced with the growth of population and ease of communication; that this specialization and co-ordination is accelerated by the invention of machinery, the discovery of processes whereby the production and distribution of greater quantities of an increased variety of products are facilitated; that this specialization and combination are of benefit to all individuals of the nation in that they bring to the control of the processes of production and distribution the men best fitted therefor, under whose directions the efforts of great bodies of workers are co-ordinated to the greatest advantage, and under whose direction the accumulations of great numbers of people can be used with profit to the investors and to the individuals of the whole nation, for this specialization and co-ordination lead to the production and distribution on an ever-extending scale and at decreasing expense of the products that contribute to the strength and fitness of the buildings in which these individuals live and work, in which they congregate for instruction, deliberation, and recreation; of the products that nourish and the products that clothe the body under the varying conditions to which it is subjected, thereby aiding each individual to preserve for the greatest period that condition which permits the effective performance of the functions dependent upon physical action.

That a powerful factor in this industrial specialization and combination and in the diffusion of the benefits thereby attained is the force known as competition. Increased demand causes increased production by an increased number of producers, who, by competition, are forced to lower selling prices and are thereby forced to the discovery, invention, and adoption of appliances and methods that decrease cost of production. Competition, still encroaching upon their profits, incites a combination of producers in self-defense, but to withstand its still active force they are compelled to production only in localities where conditions are most favorable and to vest its control in men most competent to direct it. Competition that rippled and eddied around and among the simpler organizations of employer and employee gains increase of force as the agencies of production combine, and rolls in mighty waves upon a great organization, washing away and crumbling every point of weakness, until there is left but that wall of bed rock formed by production and distribution upon the most economical basis that can be maintained with justice to producer and consumer alike.

That as the conditions incident to industrial combination have

caused a differentiation in the ranks of producers, forming the elements distinguished as capital and labor, the force of competition upon the producers has tended not only to reduce the profits of capital but the wages of labor. As capitalists have combined to protect their profits from the encroachment of competition, so have laborers combined to protect their wages from the encroachment of other laborers, the encroachment of competition acting through the capitalists, and the encroachment of the capitalists direct. And as the action of these labor organizations throughout the industrial field tends to obtain and preserve to the workingman a share of the benefit derived from the sale of products in proportion to the value of the part in the production of which his efforts have contributed, they fulfill an important function in the attainment and maintenance of that equitable relation between the consumer and producer which constitutes industrial equilibrium.

As the argument from every point of view goes to prove that industrial combinations are the products of natural forces ministering eventually to the highest good of the individuals of a community, of the community as a whole, and to community and community in domestic and international relationship alike, lawmakers should have care that in the effort to rid the tree of poisonous growth they do not interfere with the current of the life-giving sap. The object of legal enactment should be the maintenance of justice between man and man, without hampering beneficent activity that will be driven into proper channels by the same forces that give it existence.

SUNSHINE THROUGH THE WOODS.

By BYRON D. HALSTED.

THE title above might suggest a forest that has been shot through by the light of day, or some delightful dell where the rays of the sun make every spot enchanting. Quite otherwise, the lines to follow deal with the printing of pictures of sections of woods by means of the direct sunlight, and some of the points of structure thus brought to view.

If any object through which the light passes unequally in its various parts be brought close against a sensitized paper used by photographers in printing pictures from their negatives, it is evident that an impression will be produced. This print will be a negative, or, in other words, the dark parts in the subject will be light and the light parts dark. For example, the section of papaw wood shown in Fig. 1 is a negative, while in Fig. 2 is the

positive, and corresponds closely with the wood itself in its light and dark parts.

The first essential in getting prints of woods is to obtain uniformly thin sections of the wood. These are not far to seek, for Mr. R. B. Hough has become famous for his wood sections. The

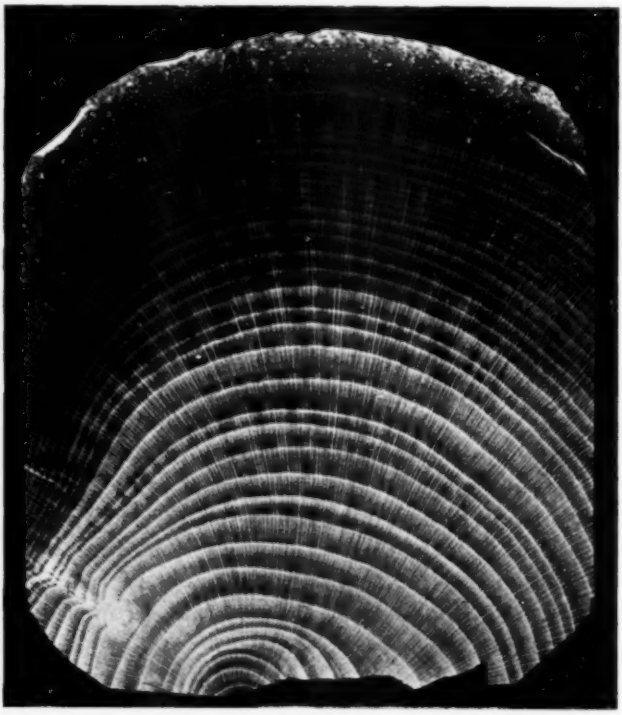

FIG. 1.—SECTION OF PAPAW WOOD. Negative.

process by which he is able to obtain his beautiful sections is not known to the writer; but to him thanks are due for the specimens which have been used in making the prints to illustrate this paper.

Having glanced at the two mentioned engravings and remembering that very much of the fineness of detail is necessarily lost in the engraving process, the reader is ready to consider the method of making the prints. The sections of wood having been secured, the only other things needful are a few "printing frames" (one will answer) of the ordinary sort used by photographers. Instead of the glass negative which the photographer uses and has prepared in the dark room, a simple plain pane of glass is needed. This is placed in the frame; upon it is put the section of wood, and over the latter a sheet of the sensitized paper. This paper is brought close upon the wood by means of the clamps, and the frame is ready to be placed in the sunlight. After the print is

made, which takes only a few minutes, the time depending upon the strength of the light and the porosity and translucency of the wood, the print is subjected to the toning process, and, after washing and drying, is ready to become the negative from which the final print is made. In order that the light may pass more readily through the negative it is soaked for a few minutes in kerosene and wiped dry upon the surface. The negative is then placed paper side down upon the plain glass in the printing frame, and upon its face is brought the sensitive side of a fresh sheet of paper, the two sheets being pressed close to each other and evenly against the glass by the clamps, as before stated. In a very brief period a positive print is obtained, which upon removal is toned in the usual way, and becomes a picture—the one, for example, furnishing the subject for the engraving in Fig. 2.

What with the brief description of the manner in which solar prints of translucent objects are made, the reader may wish to go

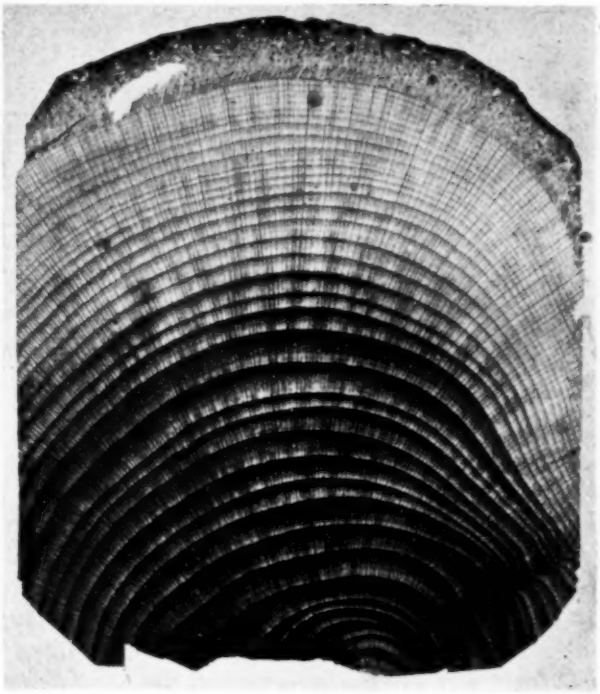

Fig. 2.—Section of Papaw Wood. Positive.

further and consider some of the differences of detail in the various kinds of wood, for one kind of timber differs from another in many ways. Should we, for example, turn to the Report on the Forests of North America, in the last census, no less than four hundred and twelve kinds of timber would be found distributed

through fifty-two natural orders of plants. Sixteen of these are heavier than water, and have a specific gravity varying from 1·3020 in the black ironwood of southern Florida to a white oak (*Quercus grisea*) of New Mexico with the wood only slightly heavier than water—namely, 1·0092 for its specific gravity. It is interesting to note in passing that all these sixteen kinds of wood that will sink in water are natives of southern Florida, a semi-tropical region, and the South and West regions, none of them growing in the Mississippi Valley or east of it.

The black ironwood above mentioned as having the heaviest wood is in many respects a striking contrast with the giant redwood (*Sequoia*) of California, which is not only the largest of our trees, but its wood is among the lightest, it having a specific gravity of only 0·2884, or about one fourth as heavy as the iron-

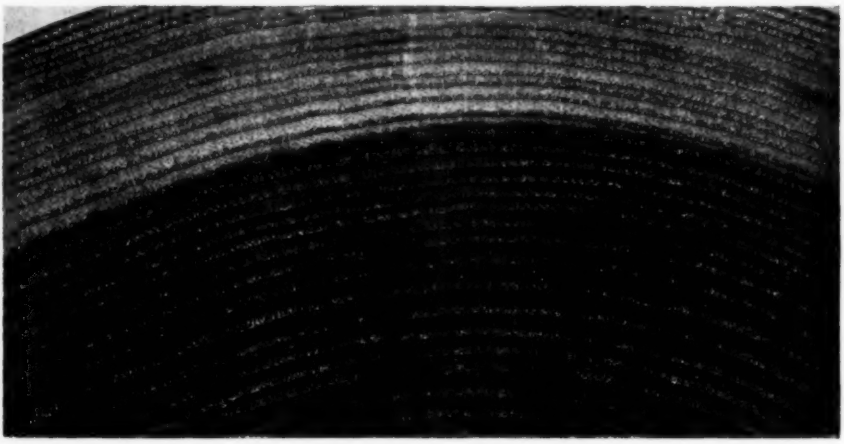

Fig. 3.—Cross Section of Ash Wood.

wood, which latter is a small, gnarly tree of no value as building timber.

It was said that there are four hundred and twelve species of timber receiving treatment in the census report, and therefore it is appropriate to show the peculiarities of the one that stands midway of this long list as regards its specific gravity, and especially so as it is one of the more common sorts and a very valuable timber for many purposes—namely, the ash (*Fraxinus*).

Fig. 3 shows the appearance of this wood as seen looking upon the smooth surface of the end of a stick of timber. It is a decidedly porous wood, as indicated by the minute, light dots which are arranged in a series of curved belts in the engraving.

This leads us naturally to consider somewhat in detail the general make-up of a stem or trunk of a tree. The primary division of the parts is into the wood and the bark. The latter is

shown in Figs. 1 and 2 as a substance quite different from the wood that lies within, and is protected by it. Growth of the stem of ordinary trees takes place in a continuous zone just beneath the bark, the latter being also supplied with new material, as it may be needed to supply the same formative layer. As the years roll on, the wood first made, while the stem was small, and

FIG. 4.—CROSS SECTION OF PIN OAK. Positive.

now situated near the center, changes its appearance by taking on some color, the shade being determined by the kind of wood. In some of the "precious woods," so called because of their great value for special purposes and possibly their variety, the central or heart wood is nearly jet black, as in the ebony. There is usually a marked difference in the color between the latest formed sapwood lying close under the bark and that formed many years before and now covered by later layers.

We have come now to consider another point of structure previously hinted at and plainly shown in the negravings, namely, the rings of wood. The tree as it enlarges from year to year leaves in its structure the evident record of its life. Each growing season is marked by a ring of wood, and only under the most adverse circumstances is this deposit omitted, and likewise extraordinary events only can lead to the formation of two rings. Therefore with a fair degree of certainty the age of a forest giant can be determined by the number of annual deposits of wood in rings around the common center.

These deposits become manifest to the naked eye, because of the difference in structure between the spring and autumn deposits, speaking of course for tree growth in the temperate regions. Glance at the papaw stem in Fig. 1, and it will be seen that the lower portion includes the heartwood nearly to the cen-

ter of the stem. This is determined by the shortness of the diameter of the lowermost segments. It goes without further saying that the annual rings in exogenous (outside growers) stems vary in age from the youngest upon the outside to the oldest at the center. The point for us to determine is the lack of uniformity in the wood and why that lack is somewhat regular. In other words, the woody tissue of a stem is heterogeneous only within certain limits. Thus in the wood shown in Fig. 1 there are thirty-nine rings, and the tree for our purpose may be considered forty years old in round numbers. Twenty of these rings, or the older half, show a marked color, being much darker than the superimposed twenty years of annual deposits. Several other things are shown by this section, and we can well dwell upon this specimen, as it illustrates facts that are common to nearly all trans-

FIG. 5.—CROSS SECTION OF PIN OAK. Negative.

verse cuts of wood. The rings, for example, are not all of the same width, those formed while the tree was passing from its fifth to the twentieth season being the largest, but even among these there is a wide variation. Thus, ring fifteen from the center is a narrow one, followed by one of unusual width. For the last ten years the rings have been more uniform and much thinner than twenty years earlier. There may be one or more of many reasons for a ring being unusually thin, as, for example, a short season, one lacking in moisture or having an excess of it, injury from frost, fires, insects, or parasitic fungi. The decrease in thickness toward the outside of the papaw may be due to insufficient nutrition, approaching old age, etc., but in this connection it must not be overlooked that the amount of actual wood deposited may be more in a thin ring at the fortieth year than in a comparatively thick one at the tenth year, the surface covered being so much

more extensive. It is likely that the root and leaf surface may not increase in the same ratio as that of the cambium or growing layer.

Let us now confine our attention to any one ring—the one, for example, near the middle of the engraving. It is bounded upon the inner and outer side by a dark line. Starting at the dark inner line, the ring of wood is very porous, as shown by the multitude of small holes giving a light appearance to this portion of the ring. Farther out the wood in the ring becomes more dense, until it ends in the almost solid outer dark band. This dense layer is in fact the last portion of the annual ring to be formed, and is laid down toward the end of the growing season. The next spring a new ring begins to form just outside this dense layer, and is often produced rapidly and with many large ducts and vessels among the woody fibers. In short, the ring of wood increases in density from the inside to the outside, and this being followed up year after year, the most dense or autumn wood is brought close to that which is the most porous, and the ring structure when seen in mass inevitably results.

It is not unusual for one side of a stem to grow faster than another, and then after a few years the center is toward one side of the middle, and the stem is called excentric. This is quite uniformly the case with all climbing stems, and the writer has a vivid recollection of a microscopic study of this subject of stem eccentricty in the poison ivy, for the work was interrupted by the swelling and closing of the eye most engaged in the task. Fig. 1 is still a fertile subject, and gives the observer a view of both this eccentricity and an irregularity not uncommon in stems. For some reason—and it might have been one of many—when the stem was about ten years old a defect developed, as shown upon the lower right-hand side, when each succeeding ring formed quite an angle that was gradually outgrown during the subsequent ten years. This blemish is shown perhaps to less advantage in the positive (Fig. 2).

The points that have been brought out in the papaw stem are also shown in the section of the ash. From what has been said it is evident that the lower side of the picture represents the inner side of the section. The center of the tree was where two pencils would intersect if held with their tips to the right and left side respectively of the lower edge of the engraving and at right angles to the curvature shown by the rings of growth. The tree from which the section used in the engraving was cut must needs have been at least a foot in diameter, but how much more can not be determined, for there is no means of knowing how far it is from the outermost ring shown to the bark. This could be determined in a general way from a knowledge of the ratio

which obtains between the sapwood and the heartwood in this species.

The ash has certain peculiarities which separate it quickly from the papaw and most other woods. There is, in short, almost as much individuality in the woody tissues as in the foliage or flowers of many trees. Note, for example, the well-marked porous

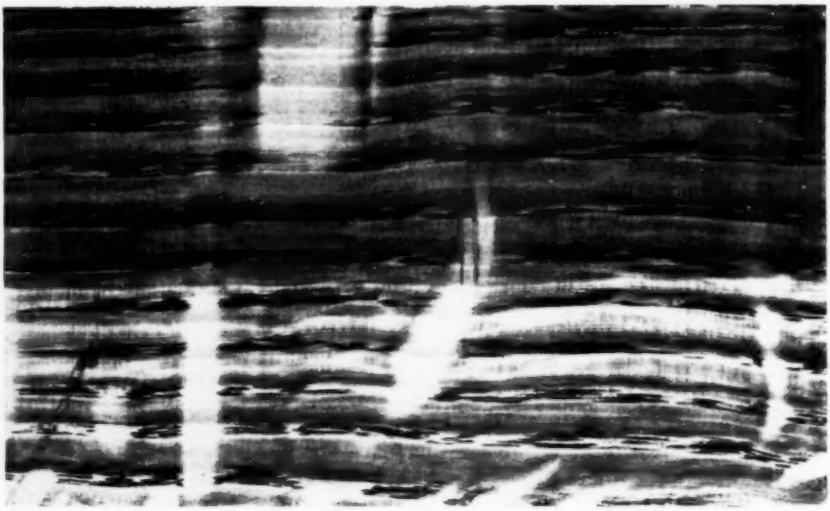

FIG. 6.—RADIAL SECTION OF PIN OAK.

portions, each ring being made up of two quite distinct parts, namely, the open vascular inner part and the dense fibrous outer portion. This arrangement of substance is conducive to that elasticity so characteristic of the ash, and, together with its medium weight, fits it for very wide and extensive service in implements and other ways.

There is another feature of woods, and one of great value from the artistic as well as economic standpoint, that the solar print illustrates. It is shown in some of its beauty in Figs. 1 and 2, while it fails quite completely in the ash—namely, the thin, radiating bands which connect the center of the ste with the periphery and are known to botanists as the medullary rays, and to the workers in wood as the "silver grain." Fig. 4 is here introduced as showing this element of structure in a remarkable manner. The section is of the pin oak, and the lower right-hand corner represents for our purpose the center of the stem. The rings of wood are wide, irregularly scalloped, and show the points of structure previously mentioned in a superior manner. But best of all are the lines shot through the whole timber like rays of light (in the negative, Fig. 5) from the center to the circumference. They introduce another element, which up to this time has been left

in the background. An exogenous stem may be said to consist of a central pith, seen best during the first years and often thereafter disappearing, and an outer ring of pithlike substance, the inner bark, and a series of plates connecting the two, also of the nature of pith. These thin plates separate incompletely the wood into wedges, and on account of them it often splits more easily in radial lines than in others, and may crack along them in ordinary drying. These thin, shiny, radiating plates of cells lying between the ordinary tissue of the wood give to some sorts of timber its beauty and value. Oak in all its strength would be lacking in much of its peculiar attractiveness were the silver grains absent. Fig. 6 shows a radial, longitudinal section of the pin oak with a few of these plates in view. They are usually small in area and appear in the finished article of furniture as shining, smooth patches, no two of the same size or shape. The beauty of this system of radiating plates is often enhanced by a curling and twisting, due to small knots scattered through the wood, as instanced in some sorts of maple, as the so-called "bird's-eye," a most attractive wood for finishing.

The birch is a good illustration of the wood being flecked, as shown in Fig. 7, a sample of the river birch. This wood is

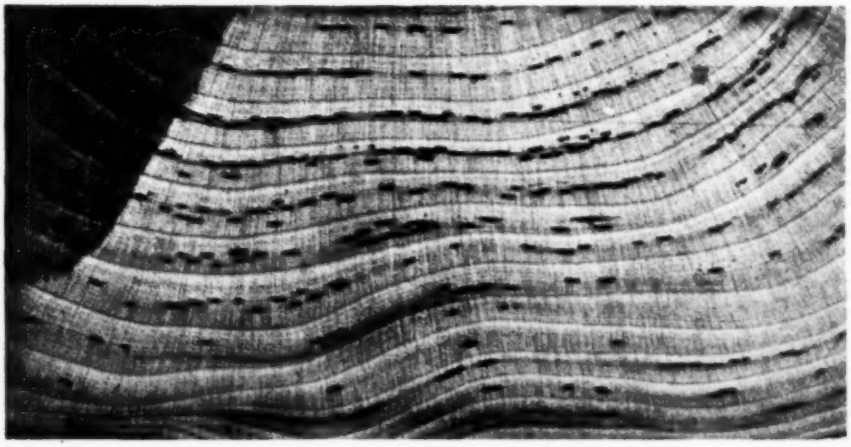

Fig. 7.—Cross Section of River Birch.

peculiar in the absence of any conspicuous medullary rays, and of prominent vascular areas in the annual rings, and therefore with the exception of the pithy patches, the wood is quite uniform throughout; but the coloration characteristics of the heart may appear upon one side of the center like a radiating fan, thus showing that the change of color is far from constant, and does not depend upon the wood having reached a certain fixed age.

Many other sections of wood might be shown, and each in its

turn would exhibit peculiarities, but the purpose of the paper it is hoped has been attained—namely, to show engravings made from sun prints of thin sections of wood with the various elements of structure in the proper position and of natural size.

A single enlarged view of a section of the ash is herewith given, and both indicate the structure seen in Fig. 8 on a larger scale, and show that pictures of such objects may well be taken

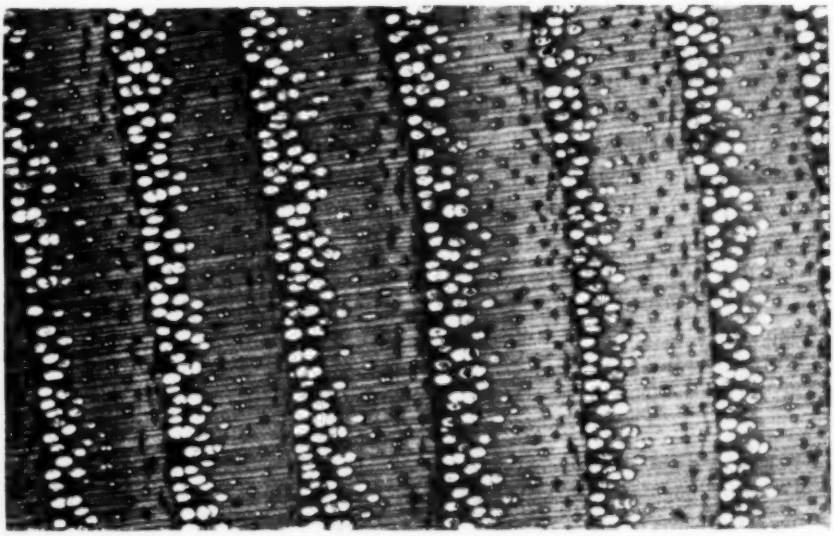

FIG. 8.—CROSS SECTION OF ASH. Magnified.

with the light passing through the object falling upon the sensitized plate in the dark chamber of the camera. By a comparison of Figs. 8 and 3 it will be seen that the two show the same ash wood in transverse section. In fact, a small portion of Fig. 3 near its center was selected for the picture from which engraving 8 was made, and this last is therefore no exception, for it was also a catching of a picture by Sunshine through the Wood.

IN his subterranean explorations from 1888 to 1893, M. Martel has found that the temperature of natural caves is not equivalent to the mean annual temperature of the place, but is inconstant; is not uniform in different parts of the same cave; and that the temperature of water in caverns is subject to the same variations as the temperature of the air, and is sometimes very different from the temperature of the air. The causes of these variations are not well understood, but as among them M. Martel mentions fissures admitting air from without; cavities in which cold air settles; and the influence of water, which cools the air through the evaporation of its oozings, or, when streams flow through the cave, brings in all the variations of the external air.

STUDIES OF CHILDHOOD.

I.—THE AGE OF IMAGINATION.

By JAMES SULLY, M. A., LL. D.,
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ONE of the few things we seemed to be certain of with respect to child nature was that it is fancy-full. Childhood, we all know, is the age for dreaming, for decking out the as yet unknown world with the gay colors of imagination, for living a life of play or happy make-believe. So that nothing seems more childlike in the "Childhood of the World" than the myth-making impulse, the overflow of fancy to hide the nakedness of things.

Yet even here, perhaps, we have been content with loose generalization in place of careful observation and analysis of facts. For one thing the play of infantile imagination is probably much less uniform than is often supposed. There seem to be matter-of-fact children who can not rise buoyantly to a bright fancy. Mr. Ruskin, of all men, has recently told us that when a child he was incapable of acting a part or telling a tale; that he never knew a child "whose thirst for visible fact was at once so eager and so methodic."* We may accept the report of Mr. Ruskin's memory as proving that he did not idle away his time in day dreams, but by long and close observation of running water and the like laid the foundations of that fine knowledge of the appearances of Nature which everywhere shines through his writings. Yet one may be permitted to doubt whether a writer who shows not only so rich and graceful a style but so truly poetic an invention could have been *in every respect* an unimaginative child.

Perhaps the truth will turn out to be the paradox that most children are at once matter-of-fact observers *and* dreamers, passing from the one to the other as the mood takes them and with a facility which grown people may well envy. My own observations go to show that the prodigal output of fancy, the reveling in myth and story, are often characteristic of a period of childhood only. We are apt to lump together such different levels of experience and capacity under that abstraction "the child." The wee mite of three and a half years, spending more than half its day in trying to realize all manner of pretty, odd, startling fancies about animals, fairies, and the rest, is something vastly unlike the boy of six or seven whose mind is now bent on understanding the make and go of machines and of that big machine the world.

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* Præterita, p. 76.

So far as I can gather from inquiries sent to parents and other observers of children, a large majority of boys and girls alike are for a time fancy-bound. A child that did not want to play and cared nothing for the marvels of story-land would surely be regarded as queer and not just what a child ought to be. Yet supposing that this is the right view, there still remains the question whether imagination always works in the same way in the childish brain. This is a point about which we are beginning to know something definite. The movements of fancy may be expected to have as many directions as the impulsive forces of young interests, and these we know are numberless. Fairies and angels (which are not differentiated in the child's consciousness), the animal world, the mysterious past before the baby came, the doings of the great people up in the sky—these appear to be some of the favorite haunts of the young fancy.

Science is beginning to aid us in understanding the differences of childish imagination. For one thing it is leading us to see that a child's whole imaginative life may be specially colored by the preponderant vividness of certain orders of images; that one child may live imaginatively in a colored world, another in a world of sounds, another rather in a world of movement. It is easy to note in the case of certain children of the more lively and active turn how the supreme interest of story as of play lies in the ample range of movement and bodily activity. Robinson Crusoe is probably for the boyish imagination more than anything else the goer and the doer.*

With this difference in the elementary composition of imagination there are others which turn on temperament, tone of feeling, and preponderant directions of emotion. Imagination is intimately bound up with the life of feeling, and will assume as many directions as this life assumes. Hence the familiar fact that in some children imagination broods by preference on gloomy and terrifying objects, religious and other, whereas in others it selects what is bright and gladsome; that while in some cases it has more of the poetic quality, in others it leans rather to the scientific or the practical type.

Enough has been said perhaps to show that the imaginativeness of children is not a thing to be taken for granted as existing in all in precisely the same way. It is eminently a variable faculty, requiring especial study in the case of each new child.

But, even waiving this fact of variability, it may, I think, be said that we are far from understanding the precise workings of imagination in children. We talk, for example, glibly about

* The different tendencies of children toward visual, auditory, motor images, etc., are dealt with by P. Queyrat, L'Imagination et ses variétés chez l'enfant.

their play, their make-believe, their illusions; but how much do we really know of their state of mind when they act out a little scene of domestic life or of the battlefield? We have, I know, many fine observations on this head. Careful observers of children and conservers of their own childish experiences, such as Rousseau, Pestalozzi, Jean Paul, Madame Necker, George Sand, have told us much that is valuable; yet I suspect that there must be a much wider and finer investigation of children's action and talk before we can feel quite sure that we have got at their mental whereabouts, and know how they feel when, for example, they pretend to enter the dark wood, the home of the wolf, or to talk with their deities, the fairies.

Perhaps I have said enough to justify my plea for new observations, and for reconsideration, in the light of these, of hasty theories. Nor need we object to a fresh survey of what is perhaps the most delightful side of child life. I often wonder, indeed, when I come across some precious bit of droll infantile acting, or of sweet child-soliloquy, how mothers can bring themselves to lose one drop of the fresh, exhilarating draught which daily wells up from the fount of a child's fantasy.

Nor is it merely for the sake of its inherent charm that children's imagination deserves further study. In the early age of the individual and of the race what we enlightened persons call fancy has a good deal to do with the first crude attempts at understanding things. Child-thought, like primitive folk-thought, is saturated with myth, vigorous Fantasy holding the hand of Reason—as yet sadly rickety on his legs—and showing him which way he should take. In the beginning of the moral life, again, we shall see how easily the realizing force of young imagination may expose its possessor to deception by others, and to self-deception too, with results that clearly simulate the guise of a knowing falsehood. On the other hand, a careful following out of the various lines of imaginative activity may show how moral education, by vividly suggesting to the child's imagination a worthy part, a praiseworthy action, may work powerfully on the unformed and flexible structure of a child's will, moving it dutyward.

The play of the young imagination meets us in the domain of sense-observation: a child is fancying when it looks at things and touches them, and moves among them. This may seem a paradox at first, but in truth there is nothing paradoxical here. It is an exploded psychological fallacy that sense and imagination are wholly apart. No doubt, as the ancients told us, fantasy comes of sense; we live over again in waking and sleeping imagination the sights and sounds of the real world. Yet it is no less true that imagination in an active constructive form takes part in the

very making of what we call sense-experience. We learn to read the visual symbol, a splash of light or color, now as a stone, now as a pool of water, just because imagination drawing from past experience supplies the interpretation, the group of qualities which composes a hard, solid mass, or a soft, yielding liquid.

Children's fanciful readings of things, as when they call the twinkling star a (blinking) eye, are but an exaggeration of what we all do. Their imagination carries them very much further. Thus they may attribute to the stone they see a sort of stone-soul, and speak of it as feeling tired.

This lively way of envisaging objects is, as we know, similar to that of primitive folk, and has something of crude Nature-poetry in it. This tendency is abundantly illustrated in the metaphors which play so large a part in children's talk. As everybody knows, a child describes what he sees or hears by analogy to something he knows already. This is called by some, rather clumsily, I think, apperceiving. For example, a small, oscillating compass needle was called by a child a bird, on the ground of a faint likeness of form and fluttering movement. M. Taine tells us of a little girl who called the eyelids prettily eye-curtains. Distant and unknown things, for example the moon, will naturally come in for much of this vivid imaginative interpretation. Thus the moon when reduced to a crescent was said by a boy of three to be broken. American children described it ingeniously as half stuck or half buttoned into the sky.* Similarly with sounds. The spluttering of coals in the fire was called barking by a little girl of four and a half years. The American children already referred to described thunder variously as a throwing down of toys, a shooting in of coals, and so forth.

This play of imagination in connection with apprehending objects of sense has a strong vitalizing or personifying element. That is to say, children, in common with uncivilized peoples, see what we regard as lifeless and soulless as alive and conscious. Thus a child will say a tree rustling in a cold wind "shivers." The tree is apprehended or "apperceived" as having sensation and behaving as the child itself behaves. Moving things come in for most of this personifying impulse. A little girl of five, pleased at being able to manage her hoop, said: "Mamma, I do b'lieve this hoop must be alive, it's so sensible; it goes where I want it to."

Children's fear of feathers, of which I have several instances, and which they have in common with uncultured folk, is proba-

* These were children entering the primary school of Boston, whose ideas are described by Dr. Stanley Hall, in an article on The Contents of Children's Minds, in the Princeton Review.

bly due to the uncanny look of a sort of ghost life as the light, unsubstantial thing slowly moves of itself from the ground and poises in mid-air. Perhaps a dog's uneasiness at the sight of leaves whisked in an eddy over the ground by the wind shows a degree of the same personifying instinct. Sometimes this endowment of things with sensation leads to a quaint manifestation of sympathy. Miss Ingelow writes of herself when a little over two years old and for about a year after: "I had the habit of attributing intelligence not only to all living creatures, the same amount and kind of intelligence that I had myself, but even to stones and manufactured articles. I used to feel how dull it must be for the pebbles in the causeway to be obliged to lie still and only see what was round about. When I walked out with a little basket for putting flowers in I used sometimes to pick up a pebble or two and carry them on to have a change; then at the farthest point of the walk turn them out, not doubting that they would be pleased to have a new view." *

This is by no means a unique example of a childish lavishing of pity on what we think the insentient world. Plant life seems often to excite the feeling. Here is a quotation from a parent's chronicle. A girl aged eight brings a quantity of fallen autumn leaves in to her mother, who says, "Oh! how pretty, F——!" to which the girl answers: "Yes, I knew you'd love the poor things, mother. I couldn't bear to see them dying on the ground." A few days afterward she was found standing at a window overlooking the garden, crying bitterly at the leaves as they fell in considerable numbers.

This is not the place to speak of the rich endowment of the animal world with human susceptibilities by the childish imagination. We all know how grotesquely the little humanitarian insists on fondling pussy, or wiping her nose, and otherwise tormenting that long-suffering quadruped, all from the kindest of motives.

Now it may be asked whether all this analogical extension of images to what seem to us such incongruous objects involves a vivid and illusory apprehension of these as transformed. Is the eyelid realized and even *seen* for the moment as a sort of curtain, the curtain image blending with and transforming what is present to the eye? Are the pebbles actually looked at as living things condemned to lie stiffly in one place? It is of course hard to say, yet I think a conjectural answer can be given. In this imaginative contemplation of things the child only half observes what is present to its eyes. One or two points of supreme interest in the visible thing, the falling of the leaf, the hiding of the eye by the

* See her article The History of an Infancy. Longman's Magazine, February, 1890.

lid, are selectively attended to; and assimilative imagination, the overlaying of the visual impression with an image called up by similarity or analogy, does the rest. In this way the actual field of visible objects is apt to get veiled, its appearance being transformed by the wizard touch of a lively childish fancy.

No doubt there are various degrees of illusion here. In its matter-of-fact and really scrutinizing mood a child will not confound what is seen with what is imagined; in this case the analogy recalled is distinguished and used as an explanation of what is seen—as when a child observed of a panting dog, "Dat bow-bow like puff-puff." On the other hand, when another little boy aged three years and nine months, seeing the leaves falling exclaimed, "See, mamma, the leaves is flying like dickey-birds and little butterflies!" it is hard not to think that the child's fancy for the moment transformed what he saw into the pretty pictures. And one may risk the opinion that, with the little thinking power and controlling force of will which a child possesses, the chances are that such assimilative activity of imagination always tends in the young brain to develop a degree of momentary illusion.

It may be added that abundant evidence goes to show that children at first quite seriously believe that all things are alive and feel. A child starts from himself as the model of a thing, and mentally fashions other things like himself. He has slowly to learn the distinction between the living and the lifeless, the sentient and the insentient. No parent who has lived with his children could, I think, doubt this. Dr. Stanley Hall's inquiries have, among other curious results, shown that out of forty-eight little ones just attaining the school age, twenty believed the moon and stars to be alive, fifteen thought a doll and sixteen thought flowers would suffer pain if burned. Perhaps a good many more had a secret belief to the same effect, but through shyness and a shrewd half-guess of the drift of the question declined to be drawn into a categorical statement. The animism of children is apt to get laughed at, and as soon as that begins they become reserved and secretive of the "contents" of their minds.

There is another way in which imagination may combine with and transform sensible objects, viz., by what is commonly called association. Mr. Ruskin tells us that when young he associated the name crocodile with the creature so closely that the long series of letters took on something of the look of the lanky creature. The same writer in his Præterita tells of a Dr. Grant into whose therapeutic hands he fell when a child. "The name" he adds, "is always associated in my mind with a brown powder—rhubarb or the like—of a gritty or acrid nature. . . . The name always sounded to me gr-r-ish and granular."

We can most of us, perhaps, recall similar experiences, where colors and sounds, in themselves indifferent, took on either through analogy or association a decidedly repulsive character. How far, one wonders, does this process of transformation of things go in the case of imaginative children? There is some reason to say that it may go very far, and that, too, when there is no strong feeling at work cementing the combined elements. A child's feeling for likeness is commonly keen and subtle, and knowledge of the real relations of things has not yet come to check the impulse to this free, far-ranging kind of assimilation. Dickens was not, one feels sure, the only child who saw odd resemblances in letters, finding, for example, that the thick O and S of his primer stood out from the rest as the easy, good-natured ones. This sort of fanciful reading of character into things is of the very life of childhood. Before the qualities and the connections of objects are sufficiently known for them to be interesting in themselves, they can only acquire interest through the combining art of childish fancy. And the same is true of associated characters. A child's ear may not dislike a grating sound, a harsh noise, as our ear dislikes it, because of its immediate effect on the sensitive organ. *En revanche* it will like and dislike sounds for a hundred reasons unknown to us, just because the quick, strong fancy, adding its life to that of the senses, gives to impressions much of their significance and much of their value.

There is a new field of investigation which is illustrating in a curious way this wizard influence which childish imagination wields over the things of sense. It is well known that a certain number of people habitually color the sounds they hear, visualizing the sound of a vowel, or of a musical tone, as having its characteristic tint which they are able to describe accurately. This "colored hearing," as it is called, is always traced back to the dimly recalled age of childhood. Children are now beginning to be tested, and it is found that a good proportion possess the faculty. Thus in the researches on the Boston children already referred to it was found that out of fifty-three, twenty-one, or nearly one half, described the tones of certain instruments as colored. The particular color, as also the degree of its brightness, ascribed to an instrument, varied greatly among different children, so that, for example, one child visualized the tone of a fife as pale or bright, while another imaged it as dark.* It is highly probable that both analogy and association play a part here.† As was recently suggested to me by a correspondent, the classic instance of the anal-

* See the article, Contents of Children's Minds, already quoted, pp. 265, 266.

† This has been well brought out by Prof. Flournoy, of Geneva, in his volume, Des Phénomènes de Synopsie (audition colorée), chap. ii.

ogy between scarlet and the note of a trumpet may easily be due, in part at least, to association of this tone with the scarlet uniform.

I may add that I once happened to overhear a little girl of six talking to herself about numbers in this wise: "Two is a dark number, forty is a white number." I questioned her, and found that the digits had each its distinctive color, thus: "one," white; "two," dark; "three," white; "four," dark; "five," pink, and so on. "Nine" was pointed and dark, "eleven" dark green, showing that some of the digits were much more distinctly visualized than others. Just three years later I tested her again and found she still visualized the digits, but not quite in the same way. Thus, although "one" and "two" were white and black as before, "three" was now gray, "four" red, "five" pink, "nine" had lost its color, and "eleven," oddly enough, had turned from dark green to bright yellow.

This case suggests that in early life new experiences and associations may modify the tint and the shade of sounds. However this be, children's colored hearing is worth noting as the most striking example of the general tendency to supplement and to overlay sense-impressions with vivid images. It seems reasonable to suppose that colored hearing and other allied phenomena,-as the picturing of numbers, days of the week, etc., in a certain scheme or diagrammatic arrangement, when they show themselves after childhood, are to be viewed as survivals of early fanciful brain work. This fact, taken along with the known vividness of the images in colored hearing, which in certain cases approximate to sense-perception, seems to me to confirm the view here put forth, that children's imagination may alter the world of sense in ways which it is hard for our older and stiff-jointed minds to follow.

I have confined myself here to what I have called the *play* of imagination, the magic transmuting of things through the sheer liveliness and wanton activity of a child's fancy. How strong, how vivid, how dominating such imaginative transformation may become will of course be seen in cases where violent feeling, and especially fear, gives preternatural intensity to the realizing power of imagination. But this effect of emotion is too large a subject to deal with here.

This playful transformation of the actual surroundings is, of course, restrained in serious moments and in intercourse with older and graver folk. There is, however, a region of child life where it knows no check; where the impulse to deck out the shabby reality with what is bright and gay has it all its own way. This region is Play. In another article, with the permission of the editor, I hope to take up the subject of children's play, considered as an expression of their imaginative activity.

A COLONIAL WEATHER SERVICE.

By ALEXANDER McADIE, M. A.

THE Signal Service was thoroughly organized as a meteorological body in November, 1870. As Americans we are justly proud of the work accomplished by it and its immediate successor the Weather Bureau. Toward the establishment and success of the meteorological service the army, the navy, and civil life contributed representative men: Myer, the soldier physician, dubbed by his countrymen "Old Probs"; Maury, the seaman whose pen could trace on many pages descriptions ever pleasing and instructive; and Ferrel, citizen professor amid military men, one so diffident and reserved that he carried to and from the meetings of the National Academy, of which he was a member, manuscripts of problems *solved*, which he would have liked to make known but that a strange shyness prevented. Forecasting weather changes had, however, been suggested earlier than the date above given. It is said that the French war office, during the siege of Sevastopol, sent to the allied fleets before the fortress information that a tempest was raging west of the Crimean Peninsula. In the United States, Redfield, Espy, Coffin, Loomis, Henry, and Lapham had argued the possibility of forecasting weather changes if systematic simultaneous observations could be had. Antedating all of these stands that unique philosopher, the printer of Philadelphia, who had discovered, before the middle of the eighteenth century, that "our northeast storms come from the northwest." Before Franklin, however, came his correspondent, Dr. John Lining, of Charleston, S. C., who kept a record of the daily temperature in 1738. Thermometers had then been in use but a few years. But the observations which were the most remarkable of all, and which up to the present time have been unnoticed if not indeed unknown, were made in Virginia about the time of the Revolution. The observers were James Madison, styled by that charming old traveler, the Marquis de Chastellux, "an eminent professor of mathematics"; and Thomas Jefferson, the Sage of Monticello. One was at Williamsburg, the colonial capital, practically near the sea; the other at Monticello, one hundred and twenty miles west and north, practically in the mountains.*

These two colonial gentlemen operated a weather service; on a small scale it is true, but the observers seem to have clearly recognized that great underlying principle of all modern weather

* A voluminous correspondence between the two is on file in the State Department, access to which was kindly granted by the Secretary of State.

FORECASTERS AT WORK, IN WASHINGTON.

bureaus, the taking of observations *simultaneously*. This, if established, removes the palm of priority from Le Verrier and France to our own country. True, no map was issued; but a century before either Le Verrier or the Signal Service, the principle which makes the map possible was thought out and tried with the best agencies at hand. Had the telegraph been in existence, there is no telling what these acute-minded colonists would have attempted.

Madison was by training and inclination a man of science, and no one can disparage Jefferson's activity as an observer. It was the practice of the latter to read his thermometer every day either at sunrise or at nine in the morning, and at sunset or four in the evening. Even the calls so frequently made upon him for active service elsewhere, while interrupting the Monticello records, did not prevent his taking observations as he journeyed. In his private expense account * we find records of temperature, rainfall, and weather jotted down with as much care and detail as expenditures. In some pages at the end of the book, the title-page of which reads, "The Philadelphia Newest Almanac for the Year of our Lord 1776, being Leap Year. . . . By Timothy Telescope, Esq." Jefferson has noted for the years 1776, 1777, and 1778 his personal expense items and detailed systematic records of temperature and rain. We turn the pages of this rare old diary slowly and there are some entries on which the eye lingers, while one wonders why these pages have not received the attention of historian and meteorologist.

On July 4, 1776, he jotted down among his expenses:

pd. Sparhawk for a thermometer	£3	/15
pd. for 7 pair of women's gloves		/27
gave in charity		1/ 6

And on July 8th the same year:

pd. Sparhawk for a barometer	£4	/10
pd. 2 dinners at Smith's		18/ 6

Sparhawk, I surmise, was an instrument-maker, and the price paid for the thermometer indicates an instrument of high order. From intimations in various places one can almost believe that the purchase of this high-priced instrument was regarded by Jefferson as an act of self-indulgence. Whether it served to relieve the mental strain incident to the doings of that ever-memorable week, or whether he was simply eager to study the new acquisition, certain it is that the entries are more than usually frequent.

* These MSS. are in the possession of the family at Edge Hill, Va., to whom I am indebted for many kindnesses.

There, in Jefferson's own fine hand, stands the record of his observations:

	HOUR.	THERM.		HOUR.	THERM.
1776, July 1:	9.00 A. M.	81½°	July 3:	1.30 P. M.	76°
	7.00 P. M.	82°		8.10 P. M.	74°
July 2:	6.00 A. M.	78°	July 4:	6.00 A. M.	68°
	9.40 A. M.	78°		9.00 A. M.	72¼°
	9.00 P. M.	74°		1.00 P. M.	76°
July 3:	5.30 A. M.	71½°		9.00 P. M.	73½°

The fourth of July, 1776, was, then, relatively cool. I think statements to the contrary have been made, and the day described as hot and sweltering. More than one historian may have drawn upon imagination in describing the weather of those first days in July when the signers of the Declaration were gathered together in Philadelphia. Strange that from the same hand that penned the Declaration should come at this late date a true statement of the weather of that period. One can not help a feeling of surprise that Jefferson, with so many duties pressing, should have found time to make these detailed observations.

The Colonial Weather Service experienced all the vicissitudes of war. Madison writes to Jefferson somewhat pathetically as follows:

"I wish we had a barometer; but there is no possibility of getting one here at present. *The British robbed me of my thermometer and barometer.*" This must have been a serious loss to the colonial meteorologists, although to us there is a touch of the ludicrous in the very idea of British soldiery relieving the college professor of his thermometer and barometer. Perhaps the instruments would have been spared could the commanding officer have foreseen that in a few years, the war ended and the colonies independent, this very professor was to go to England and be consecrated as Bishop of Virginia.

But notwithstanding interruptions, our meteorologists persevered, and their long-continued correspondence is full of *wherefores* and *whys* which even at this day are of interest and meaning. They ascertained "by contemporaneous observations of between five and six weeks" that "the averaged and almost unvaried difference of the height of mercury in the barometer at these two places was 0·784 of an inch; the pressure at Monticello being so much the lightest—that is to say, about a thirty-seventh of its whole weight.*

Furthermore—and this is truly remarkable—they proved in their own words "the variations in the weight [meaning pressure] of the air to be *simultaneous and corresponding in these two places.*" Many data were collected regarding the climate of Vir-

* Notes on Virginia, second American edition, Philadelphia, November 12, 1794.

A Modern Meteorological Observatory.

ginia. The value of the work can be judged by Jefferson's statements under Query 7 in his Notes on Virginia:

"Journals of observations on the quantity of rain and degree of heat being lengthy, confused, and too minute to produce general and distinct ideas, I have taken five years' observations, to wit from 1772 to 1777, made in Williamsburg and its neighborhood, have reduced them to an average for every month in the year, and stated those averages in the following table, adding an analytical view of the winds for the same period."

Then follows quite a long table of average temperatures and wind directions of great interest to the meteorologist. Thinking that some noteworthy differences might exist between the northeast and northwest winds at the two stations, a second table was constructed by reducing observations at the two places for nine months to the "four points perpendicular to and parallel to the coast. It may be seen that the southwest wind prevails equally at both places, that the northeast is next to this the principal wind toward the seacoast, and the northwest is the predominant wind toward the mountains; . . . the northeast wind is loaded with vapor insomuch that the salt-makers have found that their crystals would not shoot while that blows; it brings a distressing chill, and is heavy and oppressive to the spirits; the northwest is dry, cooling, elastic, and animating."

Even our valuable Crop Bulletin was foreshadowed by these early workers. We find it recorded that "white frosts are frequent when the thermometer is at 47° and have killed young plants of Indian corn at 48°, and have even been known at 54°. Black frost and even ice have been produced at 38½°."

Finally, that much-discussed matter, change in climate, did not escape their notice. "A change in climate," they claim, "is taking place very sensibly." This was written in 1781. "Both heats and colds are becoming much more moderate within memory even of the middle-aged. Snows are less frequent and less deep. They do not often lie below the mountains more than one, two, or three days, and very rarely a week."

And then follows a very evident reference to that even then well-known personage, *the oldest inhabitant:*

"The snows are remembered to have been formerly frequent, deep, and of long continuance. The elderly inform me that the earth used to be covered with snow about three months in every year."

From snows and winds these meteorologists turned their attention to rainbows, and from rainbows to water vapor and steam. Curiously enough, it is in a letter to Jefferson, mostly about the rainbow, that Madison gives the latest information about a boat to be propelled by steam and which "General W——

and others have seen and approved, and is much discussed by the well-informed; but which I must say *I feel skeptical about.*"

What a contrast! The steam navigation of that date and to-day; from the first rude paddles of the river steamboat to the triple screws of the transatlantic greyhounds! One naturally asks, "Are we to-day on the verge of a still greater navigation, that of the air?" No modern Madison may yet write that some General W—— has seen and approved, but the signs of its advent are multiplying so rapidly that he would not say, "I feel skeptical about it." If these two alert minds were again on earth, we can fancy Jefferson, always so keenly alive to practical application of knowledge, discussing the outlook as follows:

The meteorologists are exultant. In that latest instrument of the electrical engineer, the telautograph, they see the chance for an advance equal to that made when the first synoptic weather map was drawn. Simultaneity of observation can be improved upon. Instead of sending the observations in cipher twice or thrice per day, *continuous records in installments* can be sent. But even more than this, the map can be drawn *in many places at once.* The map is issued daily at a score of cities in the United States. A map is also issued daily at Brussels, Paris, London, Zurich, Hamburg, Rome, Munich, Vienna, Chemnitz, Madrid, Algiers, St. Petersburg, Simla, Brisbane, Sydney, Tokio, and Cape Town. Now one step further. *Shall there ever be one great central weather office and one great daily weather map for the whole world, drawn not in one but a hundred cities at the same moment?* Does this seem visionary? It is vastly less so than the actual system in operation for the past twenty years would have seemed to the two colonial gentlemen who more than a century ago read their barometers and thermometers *simultaneously* and speculated on the possibility of propulsion by steam.

VIEWING exact delineation by trigonometrical measurement as the crowning work of geography, Mr. Clements R. Markham pointed out, in a recent lecture, that the exact mapping of the land surface of the globe is still very incomplete, while the delineation of the bed of the ocean has hardly begun. The greatest unknown areas lie in the polar regions Even in Europe there remains scope for detailed survey in many countries. In Africa the unexplored has been diminishing very rapidly, but considerable areas are still virgin. Asia has much new ground to break into. The valleys of Hadramant in Arabia are almost as little known as the antarctic regions. Lhassa has been unvisited by Englishmen for generations, and a vast region in northwestern Thibet is still a blank on our maps. Nepaul is little known; Kafiristan is absolutely secluded from the European. The maze of mountain ranges and river valleys east of the Himalayas has yet to be unraveled, and the whole interior of Indo China is full of opportunities for research. Korea is yet far from being fully known. The great Malay Archipelago must receive more attention.

HOMES OF SOCIAL INSECTS.*

By L. N. BADENOCH.

IN no branch of insect work are more admirable means employed to bring about the desired ends, or is greater diversity of method found, than in that of insect architecture. The beauty of the buildings in many cases is incomparable, and generally speaking the abodes attain a magnitude colossal as compared with that of their creators. It may be exception will be taken to the use of the word architecture to designate this portion of the insect economy, and perhaps the term can hardly be applied in fairness to homes which are mere tunnels and galleries bored in the earth or in wood. But who would deny it to the exquisite pensile nests of the English wasps, or those of many a foreign relative, to the geometric precision exhibited within the hive of the honey bee, or to the edifices of some ants, as will be presently discovered?

Among the communities which combine their operations, there are those of which the object is simply the protection of the individuals composing them. To these societies belong the caterpillars of certain species of moths. The homes formed by these larvæ, though they are not elaborate, are interesting in several minute circumstances. But they fall short in every respect of the attractive nests fabricated by companies of insects in their perfect state, in view not only of self-preservation, but of the nurture and education of their young as well.

The nests of an extraordinary tree ant, *Œcophylla smaragdina*, are cunningly wrought with leaves, united together with web (see Fig. 1). One was observed in New South Wales in the expedition under Captain Cook. The leaves utilized were as broad as one's hand, and were bent and glued to each other at their tips. How the insects manage to bring the leaves into the required position was never ascertained, but thousands were seen uniting their strength to hold them down, while other busy multitudes were employed within in applying the gluten that was to prevent them returning back. The observers, to satisfy themselves that the foliage was indeed incurvated and held in this form by the efforts of the ants, disturbed the builders at their work, and as soon as they were driven away the leaves sprang up, with a force much greater than it would have been deemed possible for such laborers to overcome by any combination of strength. The more compact and elegant dwelling of *Œ. vires-*

* Reprinted, with the kind permission of Messrs. Macmillan & Co., from the author's popular work, Romance of the Insect World.

cens is made of leaves, cut and masticated until they become a coarse pulp. Its diameter is about six inches; it is suspended among thickest foliage, and sustained not only by the branches on which it hangs, but by the leaves, which are worked into the composition, and in many parts project from its outer wall. It may be at once distinguished from the nest of *Crematogaster* by its smoothness and regularity of surface. A species of this genus was discovered in Africa by Foxcroft, who observed that whenever the ants were molested, they rushed out of their house

FIG. 1.—NEST OF A TREE ANT (ŒCOPHYLLA SMARAGDINA) FROM INDIA.

in such numbers that their pattering upon the papery covering deluded him into thinking rain was falling on the leaves above.

In the forests of Cayenne, the nests of *Formica bispinosa* are remarkably like a sponge or an overgrown fungus. The down or cottony matter enveloping the seeds in the pods of the *Bombax ceiba* is used for their construction, vegetable fibers that are too short to convert into fabrics, but which the ants contrive to felt and weave into a compact and uniform mass, so dexterously that all trace of the individuality of the threads is lost. The material much resembles amadou, and like that substance is valuable for stopping violent discharges of blood. In size the nests generally have a diameter of eight or nine inches. The ant itself is little and dark, and noted for two long, sharp spines on its thorax, one on either side; hence its scientific name of *bispinosa*, from the Latin, meaning two-spined. Popularly it has been called the fungus ant.

The true social wasps, which are arranged in one large family, the *Vespidæ*, form communities whose architectural labors will not suffer on comparison even with those of the inhabitants of the beehive. In fact, for daintiness and delicacy the nests of many of the *Vespidæ* constitute the most beautiful examples of insect architecture.

Not the least extraordinary of the wasps are the *Icarias*, a genus that extends through most of the warmer regions of the world, specimens having been taken in Africa, India, China, and Australia, and in many parts of the Asiatic Archipelago. Like the *Polistes*, their nests are attached to leaves, stalks, or branches by a single footstalk, composed of the same papery material as the cells. Though slender, it is hard, tough, and solid, and the strength with which it is fastened to the tree or plant is surprising, enabling it to uphold considerable weight. At the end of the petiole usually a single cell, its mouth directed downward, is fixed; the rest of the nest consists of a double series of lateral cells until the group is complete. Those nearest to the footstalk are the largest and most perfect, since they are finished first; toward the other extremity the cells gradually diminish in size, and at that point they are only just begun. As a whole they are well-defined hexagons; their color is often a rather dark yellowish brown, preventing them from being conspicuous in spite of their curious projection. The cell masses are small, so that the societies must be restricted. Possibly each group is the work of a single female, who confines herself to raising her own progeny which escape as soon as they are hatched. The nests are frequently numerous in the same spot, and each society may set up a number of separate homes in the vicinity of one another. Per-

FIG. 2.—NEST OF ICARIA VARIEGATA.

haps in this genus, as among the *Polistes*, workers are wanting (see Fig. 2).

The wasps hitherto considered are distinguished as manufacturers of paper, in general fine and thin and more or less brittle, the weakness of which they overcome by the superposition of a great number of leaves. There is a large class who, while they make many kinds of papyraceous tissues, are noted for a feature in common—the fabrication of a solid and tough paper, a veritable cardboard, composed of only one layer of material, at times very thick and resisting, at others slight and supple. Of this substance, after the manner of *Vespa*, the wasps usually build a papyraceous envelope or sac for the inclosure of their combs, and as in that genus, the covering follows closely the direction of the plan of the cells.

The genus *Chartergus*, one of the important groups of the cardboard makers, includes insects apparently similar which practice two strangely different forms of nidification. The nests of *C. chartarius*, the most common in collections, are of frequent occurrence in tropical America. Their cardboard is white, gray, or of a buff color, tending to yellow, very fine and of polished smoothness; at the same time it is strong and so solid as to be impervious to the weather. It can not be urged sufficiently, says Réaumur, that this kind of envelope is indeed of a veritable cardboard, as beautiful as any we know how to make. Réaumur once showed a piece to a cardboard manufacturer, and not the slightest suspicion of its real nature was suggested to his mind. He turned it over and over, he examined it thoroughly by the touch, he tore it, and after all declared it to be made by one of his own profession, mentioning manufacturers at Orleans as the probable producers. The nests may be conical or cylindrical, they may be straight, but more often are somewhat curved; some are almost globe-shaped, but these varieties are of little importance. The length of a well-sized nest is about a foot; the largest yet discovered was in Ceylon, and measured the astonishing size of six feet. The edifice is pendulous on trees and attached, as it were, to a suspensory ring, which embraces the branch and is tightly impasted round it, or, according to Westwood, may be large compared with the latter's circumference; but it is probably a mistake to say that the nest ever swings freely as on a pivot. The interior consists of circular concave horizontal platforms of cells, their mouths turned downward, each tier stretching right across like so many floors, and fastened along its entire edge to the walls. Communication is effected by a central opening through the bottom and through every tier. When the number of inhabitants becomes very great and a fresh series of cells is added, unlike the British wasps who add to their abodes by a preliminary in-

crease of the envelope to admit of extension of the tiers, the *Chartergi* go to work on precisely the opposite plan, first forming new cells and covering them afterward. Taking the bottom of the nest as a starting point, they set cells over its exterior surface, being careful to extend the circumference by a row or two to

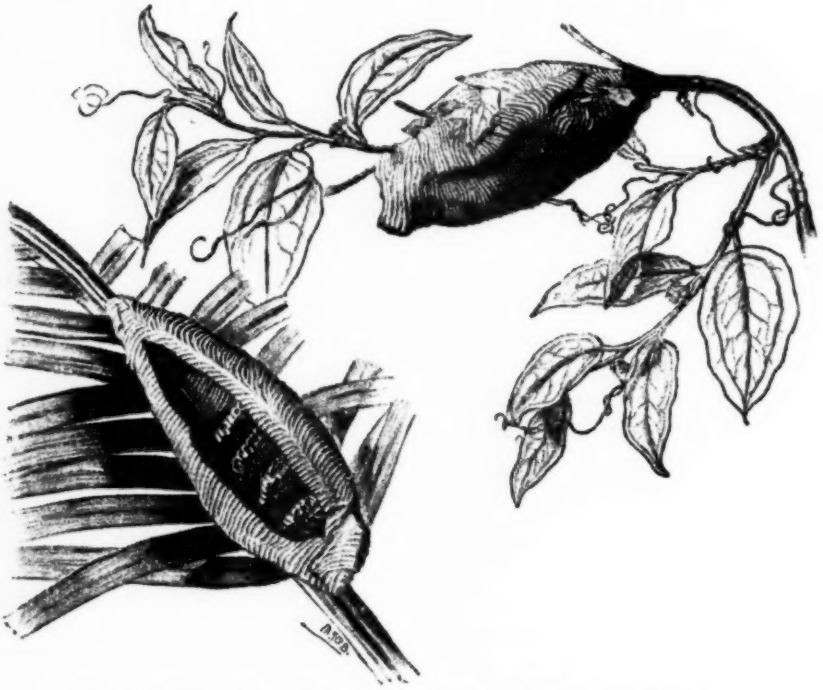

FIG. 3.—WASP'S NEST (CHARTERGUS APICALIS), INTERIOR AND EXTERIOR.

augment the diameter in proportion to the length, so that the symmetry of the building may not be lost. The walls are then lengthened to include the fresh stage, and the end is closed with a new floor, in its turn to become the ceiling of the next tier of cells when further enlargement is desired. No trace of the addition is visible on the outside of the envelope, which would seem constructed at one stroke.

The other kind of nest of *Chartergus* is constructed on a straight and upright branch, having no lateral twigs. Its elegance can not be sufficiently admired. Composed of a few cells only, the combs are attached to the branch by means of petioles, or solid masses of wax, keeping the groups in a horizontal and parallel position. They stand one over the other, sometimes to the number of ten, separated by considerable intervals, and so admirably upheld by the petioles that the aid of all pillars or columns is dispensed with. The envelope is a spindle of a single leaf of ligneous paper, most artistic in appearance, being marked with

transverse parallel tubings and goffered. The fibers of the tissue are arranged with surprising regularity; all the zones are united with consummate art, and meet in a long and plainly shown line; the paper may be also variegated with longitudinal bands of different colors. The vase is firmly fixed to its axis at points slightly above and below the uppermost and lowermost combs; at no part is it in continuity with the combs; there is plenty of space between the two fabrics for the wasps to pass up and down within their home with ease. Taking advantage of the wholly lateral position of the combs with respect to the axis, the wasps render their building less fragile than it would otherwise have been by placing the branch to one side of the spindle, and it saves time and trouble, without materially impairing the support, to leave the wood exposed at the posterior surface of the papery mass. The opening is small and situated at the lower end (see Fig. 3).

Very extraordinary are some of the nests in the collection of the British Museum—the works of *Myrapetra scutellaris* (see

FIG. 4.—VIEW OF EXTERIOR OF NEST OF MYRAPETRA SCUTELLARIS.

Fig. 4), a mere fanciful title. These huge erections are from Central America, and the native authorities say of one that it is not composed of wood fibers, but of the dung of the capincha, one of the aquatic cavies of the region. One's attention is instantly attracted to the fairly conical knobs or tubercles with

which the surface is thickly beset, of various size, and most pointed where they are least exposed. Their disposition is in horizontal zones, seeming to correspond more or less with the comb tiers. While at the top of the nest they are comparatively few, gradually the numbers increase toward the lower end, and on the bottom they are so numerous that one's finger can scarcely be laid between them. Like the envelope, they are made up of several papery layers so closely blended as to be hardly distinguishable, forming a substance astonishingly thick, hard, and firm, in color of a dull dark brown, and of very coarse texture. Of what use they are it is difficult to decide; they may be simply

FIG. 5.—VIEW OF INTERIOR OF NEST OF MYRAPETRA SCUTELLARIS.

freaks of Nature. Although their tips are not acute, they may defend the abode against the attacks of tigers, jaguars, kuguars, and other mammalia partial to honey and the grubs of the hive. The nest always hangs low, seldom more than three or four feet from the ground, and protection would appear much needed. It seems hardly possible to deny that they are for the double purpose of concealing and of sheltering the entrances, which are invisible when the nest is looked at from above. Examination reveals them beneath a row of the projections, which overhang them and keep off the rains like the eaves of a house; the passages are also intricately twisted, so as to prevent the ingress of

moths or other enemies of any size. It is strange that the interior surface of the nest is provided with tubercles, a circumstance that must put the insects to the trouble of gnawing them away each time they add a stage. Probably the same material is again employed in establishing fresh cells and in building the new platform.

A longitudinal section shows the peculiar disposition of the combs. Just as in the spherical nests of *Polybia*, the highest ones are perfect or almost perfect spheres; but this method of construction is soon found to be too laborious. A nearly globular mass of the brown paperlike substance exists at the top—the nucleus, so to speak. The first combs closely surround this, so that they form the best parts of hollow spheres; then come great arcs of circles, followed in regular order by other tiers, their rotundity becoming gradually reduced until the curve of the lower ones is extremely shallow, exactly like the tiers of *Tatua*, except that they exhibit a trifling convexity on their lower surfaces. They are carried to the common wall and thereto affixed, small spaces being left open here and there between their edges and the envelope. The solid wall at the top is of great thickness (see Fig. 5).

In the nest in the British Museum already described, a quantity of brownish-red honey was found in the upper combs, but hard and dry. Even so long ago as the beginning of the century, Azara, a Spanish officer, who was sent out by his Government to Paraguay to make certain investigations in that country, mentions that a South American wasp which he calls chiguana has the strange habit of hoarding honey. The chiguana of Azara, it would seem, is identical with *Polybia scutellaris*. At the time of publication Azara's statement was not believed, so opposed was the habit that he claimed for this insect to the known actions of wasps. He and his men ate from the chiguana's store, and it proved deleterious. St. Hilaire, a subsequent traveler, speaks of two South American honey wasps. The honey of one was white and innocuous, that of the other was reddish brown and poisonous. The good honey was in an oval, light-colored nest of thin, papery material, totally different from the paper of *Myrapetra*, and was observed by Hilaire on a small bush near Uruguay, at a distance of only about a foot from the ground. This wasp has been described as lecheguana. Probably under the term lecheguana, or chiguana, as Azara has it, the inhabitants of America confound many wasps of similar kinds, and it is rather a generic title for all honey wasps than for one species in particular.

LATITUDE AND VERTEBRÆ.

A STUDY IN THE EVOLUTION OF FISHES.

By DAVID STARR JORDAN.

IN this paper is given an account of a curious biological problem and of the progress which has been made toward its solution. The discussion may have a certain popular interest from the fact that it is a type of many problems in the structure and distribution of animals and plants which seem to be associated with the laws of evolution. In the light of these laws they may be more or less perfectly solved. On any other hypothesis than that of organic evolution the solution of the present problem, for example, would be impossible. On the hypothesis of special creation a solution would be not only impossible but inconceivable.

It has been known for some years that in several groups of fishes (wrasse fishes, flounders, and "rock cod," for example) those species which inhabit northern waters have more vertebræ than those living in the tropics. Certain arctic flounders, for example, have sixty vertebræ; tropical flounders have, on the average, thirty. The significance of this fact is the problem at issue. In science it is assumed that all facts have significance, else they would not exist. It becomes necessary, then, to find out first just what the facts are in this regard.

Going through the various groups of nonmigratory marine fishes we find that such relations are common. In almost every group the number of vertebræ grows smaller as we approach the equator, and grows larger again as we pass into southern latitudes.

It would be tedious to try to prove this here by statistical tables, but the value of generalization in science depends on such evidence. This proof I have elsewhere* given in detail. Suffice it to say that, taking an average netful of fishes of different kinds at different places along the coast, the variation would be evident. At Point Barrow or Cape Farewell or North Cape a seineful of fishes would perhaps average eighty vertebræ apiece, the body lengthened to make room for them; at Sitka or St. Johns or Bergen, perhaps, sixty vertebræ; at San Francisco or New York or St. Malo, thirty-five; at Mazatlan or Pensacola or Naples, twenty-eight; and at Panama or Havana or Sierra Leone, twenty-five. Under the equator the usual number of vertebræ in shore fishes is

* In a more technical paper on this subject entitled Relations of Temperature to Vertebræ among Fishes, published in the Proceedings of the United States National Museum for 1891, pp. 107–120. Still fuller details are given in a paper contained in the Wilder Quarter-Century Book, 1893.

twenty-four. Outside the tropics this number is the exception. North of Cape Cod it is virtually unknown.

The next question which arises is whether we can find other conditions that may affect these numbers. These readily appear. Fresh-water fishes have in general more vertebræ than salt-water fishes of the same group. Deep-sea fishes have more vertebræ than fishes of shallow waters. Pelagic fishes and free-swimming fishes have more than those which live along the shores, and more than localized or nonmigratory forms.* The extinct fishes of earlier geological periods had more vertebræ than the corresponding modern forms which are regarded as their descendants. To each of these generalizations there are occasional partial exceptions, but not such as to invalidate the rule.

All these effects should be referable to the same group of causes. They may, in fact, be combined in one statement. All other fishes have a larger number of vertebræ than the marine shore fishes of the tropics. The cause of the reduction in numbers of vertebræ must therefore be sought in conditions peculiar to the tropical seas. If the retention of the primitive large number is in any case a phase of degeneration, the cause of such degeneration must be sought in the colder seas, in the rivers, and in oceanic abysses. What have these waters in common that the coral reefs, rocky islands, and tide pools of the tropics have not?

In this connection we are to remember that the fewer vertebræ indicates generally the higher rank. When vertebræ are few in number, as a rule each one is larger. Its structure is more complicated, its appendages are larger and more useful, and the fins with which it is connected are better developed. In other words, the tropical fish is more intensely and compactly a fish, with a better fish equipment, and in all ways better fitted for the business of a fish, especially for that of a fish that stays at home.

In my view the reduction in number and increase of impor-

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* This is especially true among those fishes which swim for long distances, as, for example, many of the mackerel family. Among such there is often found a high grade of muscular power, or even of activity, associated with a large number of vertebræ, these vertebræ being individually small and little differentiated. For long-continued muscular action of a uniform kind there would be perhaps an advantage in the low development of the vertebral column. For muscular alertness, moving short distances with great speed, the action of a fish constantly on its guard against enemies or watching for its prey, the advantage would be on the side of few vertebræ. There is often a correlation between the free-swimming habit and slenderness and suppleness of body, which again is often dependent on an increase in numbers of the vertebral segments. These correlations appear as a disturbing element in the problem rather than as furnishing a clew to its solution. In some groups of fresh-water fishes there is a reduction in numbers of vertebræ, not associated with any degree of specialization of the individual bone, but correlated with simple reduction in size of body. This is apparently a phenomenon of degeneration, a survival of dwarfs where conditions are unfavorable to full growth.

tance of the individual vertebræ are simply part of this work of making a better fish. Not a better fish for man's purposes—for Nature does not care a straw for man's purposes—but a better fish for the purposes of a fish. The competition in the struggle for existence is the essential cause of the change. In the center of competition no species can afford to be handicapped by a weak backbone and redundant vertebræ. Those who are thus weighted can not hold their own. They must change or perish.

The influence of cold, darkness, monotony, and isolation is to limit the struggle for existence, and therefore to prevent its changes, preserving through the conservation of heredity the more remote ancestral conditions, even though they carry with them disadvantages and deficiencies. The conditions most favorable to fish life are among the rocks and reefs of the tropical seas. About the coral reefs is the center of fish competition. A coral archipelago is the *Paris* of fishes. In such regions is the greatest variety of surroundings, and therefore the greatest number of possible adjustments. The struggle is between fish and fish, not between fishes and hard conditions of life. No form is excluded from the competition. Cold, darkness, and foul water do not shut out competitors, nor does any evil influence sap the strength. The heat of the tropics does not make the water hot. It is never sultry nor laden with malaria. The influence of tropical heat on land animals is often to destroy vitality and check self-activity. It is not so in the sea.

From conditions otherwise favorable in arctic regions the majority of competitors are excluded by their inability to bear the cold. River life is life in isolation. To aquatic animals river life has the same limitations that island life has to the animals of the land. The oceanic islands are behind the continents in the process of evolution. In like manner the rivers are ages behind the seas.

Therefore the influences which serve as a whole to intensify fish life, and tend to rid the fish of every character or structure it can not "use in its business," are most effective along the shores of the tropics. One phase of this is the reduction in numbers of vertebræ, or, more accurately, the increase of stress on each individual bone.

Another phase is the process of *cephalization*, the process by which the head becomes empnasized and the shoulder bones and other structures become connected with it or subordinated to it. Still another is the reduction and change of the swim-bladder and its utter loss of the function of lung or breathing organ which it occupied in the ganoid ancestors of modern fishes.

Conversely, as these changes are still in operation, we should find that in cold waters, deep waters, dark waters, fresh waters,

inclosed waters, and in the waters of past geological epochs, the process would be less completed, the numbers of vertebræ would be larger, while the individual vertebræ remain smaller, less complete, and less perfectly ossified.

This, in a general way, is precisely what we do find in examining the skeletons of a large variety of fishes.

The life of the tropics, so far as fishes are concerned, offers many analogies to the life of cities, viewed from the standpoint of human development. In the cities in general, the conditions of individual existence for the man are most easy, but there also competition of life is most severe. The struggle for existence is not a struggle with the forces and conditions of Nature. It is not a struggle with wild beasts, unbroken forests, or stubborn soil, but a competition between man and man for the opportunity of living.

It is in the city where the influences which tend to modernization and concentration of the characters of the species go on most rapidly. It is adaptation or death to each individual in the city: every quality not directly useful tends to become lost or atrophied.

Conversely, it is in the "backwoods," the region farthest from human conflicts, where primitive customs, antiquated peculiarities, and useless traits are longest and most persistently retained. The life of the "backwoods" may be not less active or vigorous, but it will lack specialization. It is from the unused possibilities of the "backwoods" that the progress of the future comes. The high specialization of favored regions unfits its subjects for life under changed conditions. The loss of muscular power is often one of the results of skeletal specialization.

The coral reef is the metropolis of the fish. The deep sea, the arctic sea, and the isolated rivers—these are the ichthyological backwoods.

An exception to the general rule in regard to the numbers of vertebræ is found in the case of the eel. Eels inhabit nearly all seas, and everywhere they have many vertebræ. The eels of the tropics are at once more specialized and more degraded. They are better eels than those of northern regions, but, as the eel is a degraded type, they have gone further in the loss of structures in which this degeneration consists.

It is not well to push this analogy too far, but perhaps we can find in the comparison of the tropics and the cities some suggestion as to the development of the eel.

In the city there is always a class which follows in no degree the general line of development. Its members are specialized in a wholly different way. By this means they take to themselves a field which others have neglected, making up in low cunning what they lack in humanity or intelligence.

Thus, among the fishes, we have in the regions of closest competition this degenerate and non-fishlike type, lurking in holes among the rocks, or creeping in the sand, thieves and scavengers among fishes. The eels thus fill a place otherwise left unfilled. In their way they are perfectly adapted to the lives they lead. A multiplicity of vertebral joints is useless to the typical fish, but to the eel, strength and suppleness are everything. No armature of fin or scale or bone is so desirable as its power of escaping through the smallest opening.

DEATH OF PROFESSOR BILLROTH.

PROF. CHRISTIAN THEODOR ALBERT BILLROTH, one of the most eminent surgeons of the century, died at the Austrian winter resort Abbazia, on the Adriatic, February 6, 1894, in the sixty-fifth year of his age. He was born at Bergen, on the island of Rügen, the son of a Swedish Lutheran pastor, April 26, 1829; began the study of medicine in 1848 at Greifswald, in Pomerania, and, having continued his course at Göttingen and Berlin, was graduated in medicine from the latter university in 1852. He then traveled, after the manner of German professional students, visiting the schools of Paris and Vienna; served for several years as an assistant in the clinic of Prof. von Langenbeck, in Berlin; qualified as *Privat Docent* in the University of Berlin in 1856; became Professor of Surgery at Zurich in 1858, and in 1867 at Vienna, where he spent the rest of his professional life. He was made a member of the Austrian Chamber of Peers in 1887.

The beginning of his career as a professor in the University of Zurich was very modest. He had only ten pupils during his first semester, and his private practice, he was accustomed to say, was not enough "to pay for his morning cup of coffee." His reputation, however, quickly grew; students flocked to his lectures; and with the co-operation of eminent colleagues, notably Griesinger, the British Medical Journal says, he in a few years raised the Medical Faculty of Zurich to a prominent place among German-speaking schools. His clinic in Vienna, the same journal observes, has been for more than twenty-six years "a kind of surgical Mecca to which scientific pilgrims from all parts of the world have resorted in constantly increasing numbers. . . . Here his operative triumphs were won. He excised the larynx for cancer in 1868; performed resection of the œsophagus; and first resected the stomach in 1881 for removing cancer of the pylorus. During the Franco-German War of 1870–'71 he served in the mili-

tary hospitals at Mannheim and Weissenburg, and obtained there so close and realizing views of the horrors of war that he was afterward one of the most earnest and persistent advocates of peace. His experience there also bore fruit in an address which he delivered in December, 1891, on the care of the wounded in war, which led to a large appropriation by the Austrian Chambers for the provision of adequate means of succor for the wounded; and great improvements have been made in the transport of the wounded and in ambulance service generally. He was the founder of the Rudolphin-Haus, a school for hospital nurses, and projected a model hospital in Vienna, made up of separate and isolated dwellings.

Prof. Billroth's literary activity is pronounced immense. He was the author of about one hundred and forty books and papers. Among the more important of them are the Deutsche Chirurgie, which he prepared in connection with Lücke; the Text-Book of General and Special Surgery of Billroth and Von Pitha, published in 1882, to which he contributed the section on Scrofulosis and Tuberculosis, Injuries and Diseases of the Breast, Instruments and Operations, Frostbites, etc.; Nursing at Home and in Hospital; General Surgical Pathology and Therapeutics, which has been translated into nine languages; Clinical Surgery, or Reports of Surgical Practice between the Years 1860 and 1876, which was translated for the Sydenham Society, London, in 1881; Surgical Letters from Mannheim and Weissenburg, recording the results of his experiences and observations in military surgery; and his papers on the management of gunshot wounds and on the transportation of the wounded.

As an operator, Sir William MacCormac says of him that "his knowledge and boldness were only equaled by his brilliant execution and skill; and what he did and his reasons for doing it were explained to his overflowing class with a rare talent for exposition." Mr. Clinton Dent, the translator of his Clinical Surgery, credits him with uniting the two qualities of ingenuity and boldness in devising operations with the manipulative skill, decision, and tact required to carry them out. "Yet it was always the guiding intellect rather than the manual dexterity which

impressed itself on the spectator. Truth to say, in actual performance of an important operation Billroth showed no marked superiority over his fellow-surgeons. He avoided any show of brilliancy or flourish, went steadily to work, erred, if at all, on the side of slowness, and was neither more nor less discomposed by any complication or untoward event than any one else. The finish of his operative work was rather the result of his immense experience than of any remarkable aptitude. . . . From first to last he was never a specialist, and his operative experience was singularly varied."

Dr. A. Wölfler, of Gratz, one of his most famous pupils, thinks that the chief power of his fame was not so much in his actual inventions in surgery as in the larger and more general ideas in medicine and surgery which he suggested. In the days when bacteriology was still groping in the dark—twenty years ago—he made successful investigations of a bacterium of wounds which he called streptococcus. In another direction he established and gave effect to general principles in nursing. His highest aim was to look out for the well-being and care of sufferers. Only in his later years did he busy himself with biological questions, and then pursued them with indefatigable ardor and persistence. His works are the classical text-books in Germany.

Prof. Billroth's earliest studies were in music, to which he was devotedly attached, and he retained a strong love for the art and its apostles. He was an excellent performer on the pianoforte and violin, and maintained a close friendship with Johann Strauss, Wagner, and Brahms.

THE GREAT BLUESTONE INDUSTRY.

By HENRY BALCH INGRAM.

HOWEVER unhappy New York city may be in the matter of pavements between curbs, there is one fact apparent to the most casual observer, and that is that New York has the finest and best sidewalk pavements of any city in the universe. This is due to the fact that the sidewalks are largely paved with huge flat slabs of a natural product known in the commercial marts of New York as North or Hudson River bluestone. These slabs, which form smooth and dry platforms for the use of pedestrians, come from the quarries much in the same shape as they are laid upon the walks of nearly all of the Atlantic coast and many of the inland cities.

North River bluestone is a fine-grained compact sandstone, extremely hard and wearing upon a tool, and is made up of microscopic crystals of the sharpest sand. It abounds in inexhaustible

quantities in a belt of country reaching from the Helderberg Mountains in Albany County, in this State, diagonally across the southeastern portion of the State and into Pike and Wayne Counties in Pennsylvania. The bluestone belt varies in width, being in the shape of a scalene or elongated obtuse triangle, no two sides of which are equal. In Albany County, at Reidsville and Dormansville, and Greene County, composing the northern extremity of the belt, the territory producing good marketable stone is narrow, being confined to the foothills of the eastern watershed of the Catskills and the southern slope of the Helderbergs. The stone quarried here is gray in color, with frequent tinges of

FIG. 1.—BLUESTONE QUARRY AT WEST HURLEY, N. Y.

greenish and light-red and brown streaks, caused by the presence of calcite and ferric oxides. This stone is not regarded with favor by dealers, and brings a much lower price than the dark-blue product quarried farther down the river. The industry is also a vanishing one here, for the top matter to be removed in the quarries has become so heavy as the strata dip into the hills that few quarries pay to work at the present price paid for flagging stone. Many of the best-paying quarries of other days have been abandoned, and in consequence the ports of New Baltimore, Coxsackie, Athens, and Malden, particularly the last, have declined very much in importance since the shipments of stone have fallen off.

The bluestone belt follows the Hudson River until the town

of Saugerties, in Ulster County, is reached, when it takes a westward drift, being interrupted on the east by the older limestone formations, and on the north by the quartzose and conglomerate or pudding-stone formations of the Catskills, the latter of which undoubtedly rests on a foundation of bluestone, as it again makes its appearance on the westward side of the range. In the town of Saugerties the gray color of the stone disappears, and the formation takes on the deep-blue tinge whence it gets its name. Here also the belt begins to widen, and when the broad plateau at the foot of the Catskills, covered by the adjoining towns of Kingston, Woodstock, Olive, Marbletown, Hurley, and Shandaken, is reached, the quarries are distributed over a range of country at least fifty miles broad. Here the stone varies but little in color, touching only the shades from medium to dark blue. The presence of ferric oxides is found in all the quarries, but only in the seams on the surface of the slabs, which have a rusty color from the oxidation. The stone produced in Ulster County has always commanded the largest prices, it being the best quality produced in the entire belt.

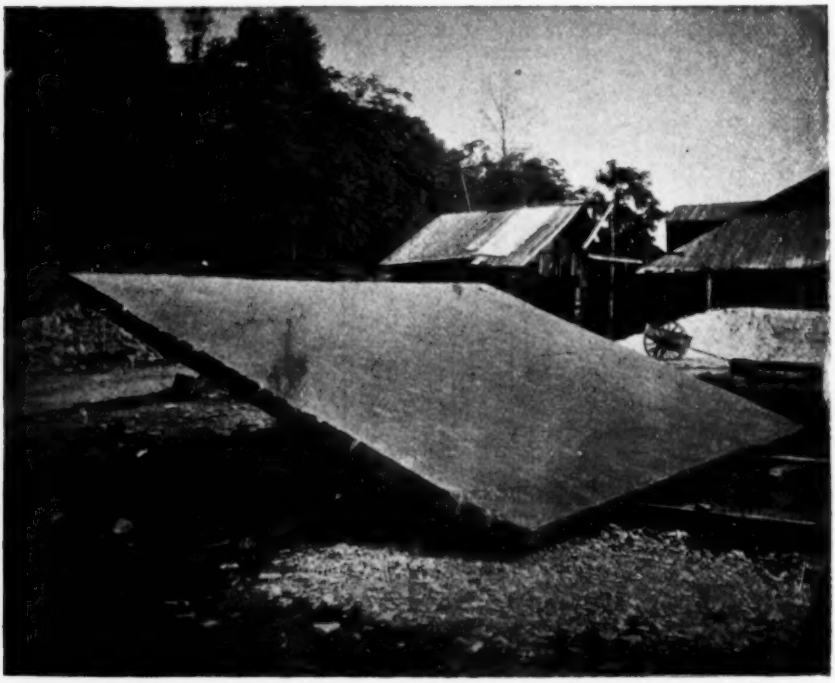

FIG. 2.—AN ULSTER COUNTY MONOLITH. Size, twenty by twenty-four feet; nine inches thick.

Leaving Ulster County, the bluestone belt crosses the Catskills, takes in a corner of Delaware and Orange Counties, and then

crosses Sullivan County until the Delaware River is reached, where quarrying is carried on all the way from Port Jervis to Narrowsburg on both sides of the river. Very little quarrying is done through the mountainous districts, although many quarries have been opened with a fair profit in Delaware County along the line of the Ulster and Delaware Railroad. The stone produced here, as well as along the Delaware River, is of a deep-red color, contains large quantities of ferruginous matter, is of uneven texture, requiring more cutting, and is much inferior to the stone quarried in Ulster County.

The history of the discovery and first attempt to quarry bluestone for the market is shrouded in uncertainty. It is known,

FIG. 3.—QUARRYMAN'S HOME WITH RUBBISH BANKS IN REAR, WEST HURLEY, N. Y.

however, that a man named Moray opened a quarry at what has since been called Moray Hill, near Kingston, as early as 1826. His son, the late Daniel Moray, of Kingston, said that his father was the first person to put bluestone as a product on the market, drawing the stone to Kingston with an ox team and selling it for window-sills and lintels. Philip Van de Bogart Lockwood was the most prominent producer of bluestone for many years after this, hauling the quarried product to the docks at Kingston Point, where it was loaded on sailing vessels and taken to the New York market. Later on, Abijah Smith built a dock and bought stone at Wilbur, which he shipped to New York, and in the early fifties the industry became so important that a plank road, eleven miles in length, was built on the Ulster and Delaware turnpike through

the quarrying country, for the better trucking of stone to the docks at Wilbur.

Some of the quarries have been veritable gold mines. One in particular, known as the great Lawson Quarry, at West Hurley, is said to have produced over four million dollars' worth of flag and other classes of bluestone. This quarry was worked by Lucius Lawson, now of Chattanooga, Tenn., for fully thirty years, and in it nearly two thirds of a village of three hundred people earned their living. The great quarry has now been abandoned, as the top has got so heavy that it does not pay to remove it to get at the good stone. In consequence of its abandonment, the village of West Hurley has dwindled to less than one third its former size, and is rapidly becoming a deserted village. Hundreds of other quarries have been abandoned for similar reasons, yet the whole bluestone district of Ulster County is thickly dotted with new quarries, which are opened as soon as the old ones are abandoned.

In working the quarries there is a great difference in the thickness of the slabs taken out. The formation exists in perpendicular blocks of different surface dimensions which are formed of flat plates piled up like cardboard. The top of worthless stone and earth is first removed by blasting with powder, after which wedges are driven in the natural seams which separate the plates, lifting them up, after which they are hoisted out with derricks. In working a block the slabs may run to several thicknesses, varying from two to ten inches. The thin slabs are then cut up into what is known as Corporation four and five foot flag and smaller sizes, while the heavier blocks are preserved intact for such huge platforms as we see reaching from building to curb line on the sidewalks of New York. Many of the blocks worked are so small in surface area that they are unfit for flagging, and are consequently worked up in coping, pillar caps, window and door sills and lintels, building and bridge stone for tramways. Other blocks are found suitable for curb and gutter alone, while some quarries furnish slabs so small and thin that they are used only for floor tiling, or for the facing of brick walls. Again, some of the slabs, or more properly platforms, taken from the quarries are from twenty to thirty feet square, ten inches thick, and weigh over twenty tons. Owing to the difficulty in handling and the danger of breakage during transportation, these platforms are seldom taken to tide water, but are broken up at the quarries into more convenient sizes for handling. Sometimes, however, monoliths of tremendous size and weight have been transported to the docks at Wilbur, the one shown in the illustration being twenty by twenty-four feet in surface area, nine inches thick, without a flaw, and weighing several hundredweight over twenty

tons. It was quarried at the Sawkill, in the town of Kingston, and is said to be the largest stone ever brought to tide water. It took eight horses to haul this monster to the docks over a stone tramway, and it is alleged that the side of a tollgate had to be taken down to allow the stone to pass through. In quarrying bluestone much stone that is practically worthless is met with. Sometimes what looks at first glance like a fine, straight-seamed block will be uncovered, when, at the first attempt to work it, it will break up into small pieces like a pile of brick. These blocks are known to quarrymen as cat faces. This formation exists in small blocks between all good working blocks, as well as sometimes in the

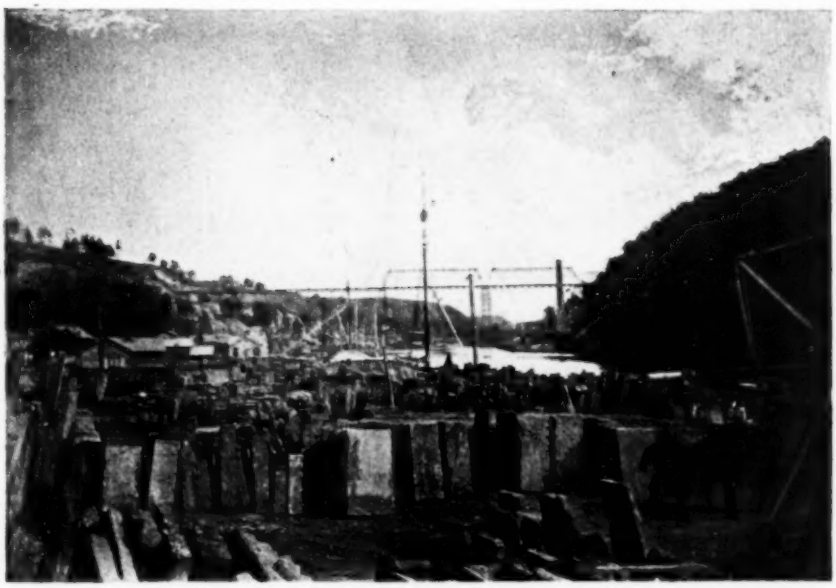

FIG. 4.—SHIPPING DOCK ON RONDOUT CREEK AT KINGSTON, N. Y.

larger ones. Cat faces are worked up into blocks for street paving, many having been used in the Hudson River cities, where they are set so the wear cuts across the grain, and have been found to wear superior to granite block, as they never become slippery, and furnish always a sure footing for horses. The worthless stone of the quarries, called rubbage, is hauled to the dumps, where immense mountains of broken stone, often one hundred feet in height and several acres in extent, have been built up.

The quarrying of bluestone and its allied industries furnish employment at good wages to a large number of people. It is estimated that throughout the entire bluestone country—reaching from Albany County, New York, to the Pennsylvania region on the Delaware River—at least twenty thousand people get all or a

portion of their support from the bluestone industry, while in the larger cities outside the bluestone belt hundreds of stonecutters are employed in dressing the stone. The wages run from a dollar and a quarter a day for common laborers to three dollars and a half a day for stonecutters, blacksmiths, tool makers, expert quarrymen, and other skilled labor. It would be hard to give a correct estimate as to the exact number of people who profit by the bluestone industry, as its influence is felt in all branches of mercantile trade, in lines of both water and land transportation, and, in fact, every industry throughout the district where the stone is found. To paralyze the bluestone traffic would mean to paralyze all branches of trade throughout that country.

FIG. 5.—BLUESTONE SAWING AND PLANING MILLS AT KINGSTON, N. Y.

The bluestone trade amounts to nearly three million dollars annually, two thirds of which is paid out in wages.

The manner of working bluestone after it leaves the quarries is worthy of notice. Before it is taken to the docks the stone receives only a superficial dressing. At the docks it is piled up, and such as is needed to fill immediate orders is sent to the cutting mills. Here the large slabs are laid on huge bed planers and planed smooth as a board. Others are sent to the saws, which consist of a gang of thin strips of plate iron, running horizontally over the surface of the stone. Under the edges of the saws, which are toothless, is kept a supply of wet sand very sharp in grain. The constant grinding of the saws in the sand soon cuts into the stone and rends it into slabs or bars of the required size. Other stone

which is required to have a perfectly smooth surface is placed on huge revolving platforms of cast iron, the surface of which is kept covered with a thin coating of wet sand. The platform, revolving at high speed under the stone, soon rubs it smooth as polished metal—without the polish, however, as bluestone is not susceptible of polish. Other stone is dressed by hand by the stonecutters, who tool it with chisels and axes into different shapes. It is also turned in lathes in the shape of hitching posts, columns, and other forms, while it is susceptible of the most intricate carving, and is used at present in many classes of sculptured work for the ornamenting of buildings. Its extreme hardness makes it proof against all atmospheric changes, and it will neither shell like brownstone nor crumble like marble under the action of frost. It disintegrates and explodes, however, with terrific force under the action of intense heat.

The bluestone formation of New York State lying in Ulster County belongs to the Hamilton period, while that quarried in the other counties mentioned belongs to the Catskill group of rocks of the Upper Devonian age. As far as the writer has been able to learn, minerals are never found in the bluestone deposits, except in the form of oxides. Ignorant prospectors have at times reported the discovery of anthracite coal, which, however, has always proved to be a worthless deposit of organic slate, which in some localities abounds in considerable quantities. It is improbable that coal will ever be found in this region, as the stone formations that lie nearest the surface are those which underlie the coal measures of the entire country.

LADY MARY WORTLEY MONTAGU AND MODERN BACTERIOLOGY.

By Mrs. H. M. PLUNKETT.

IN all the history of modern scientific progress there is no more beautiful instance of the way in which the torch of knowledge is passed from hand to hand as generation succeeds generation, each holder adding his increment of light to the flame, than that to be seen in the interlinking of the work of Lady Mary Wortley Montagu and Edward Jenner with that of Pasteur and Lister and Koch, and the multitude of illustrious seekers now striving to reveal to us the whole world of man's microscopical friends and enemies. It is to be noted that in each individual case the mind that was to aid in setting forward the hand on the dial of progress was specially gifted for its work, so that when the new truth was presented to it, it was like the seed that fell on

good ground and brought forth fruit a hundredfold; while the knowledge of the same facts—always existent—had, outside of these illuminated intelligences, fallen on the stoniest kind of soil.

The relation of the beautiful and brilliant and witty Lady Montagu to one of the most beneficent applications of knowledge to the abatement and mitigation of human suffering, is at the present time very inadequately understood. Even in this day of boasted intelligence nine out of ten among persons who consider themselves well informed will say, "Yes, I know Lady Mary Wortley Montagu was the woman who introduced vaccination into England," whereas it was inoculation for smallpox that she had introduced. This produced a mild form of the disease, perfectly protective, and left no marks. Others had observed this Oriental practice, and had brought the knowledge back to England before her time, and here and there a venturesome individual had tried the experiment, but it was generally done in secret, being looked upon as akin to suicide. It was Lady Mary's intelligent enthusiasm that brought it into repute; she explained the conditions necessary to success, and set the example of having all belonging to her subjected to it. Her only brother had died of smallpox, and she had had it severely; it disfigured her to the extent of destroying a fine pair of eyebrows, resulting in imparting a fierce and disagreeable expression to her eyes, in spite of which she had won the heart and hand of an accomplished gentleman. Remember, this was in the first quarter of the last century, when communication between distant lands was infrequent, and women's books were almost unknown.

Her husband had been appointed in 1716 ambassador to the Ottoman court, and she had accompanied him, being then twenty-six years old. They made the journey overland through Germany, Austria, Bohemia, and Bulgaria, being the first Christians that had passed over the route since the time of the Greek emperors. It occupied more than four months, and, although hospitably entertained by the sovereigns in the large cities, as the representatives of their government, there were long reaches of country where they were obliged to use the beds and provisions that they carried along with them. She wrote back lively and brilliant descriptions of Eastern life in letters that to this day are "mighty interesting reading," the arrival of each being an event in the court coterie of her friends; they were passed from hand to hand, commented on, and enjoyed with a relish that the surfeited readers of to-day can not know, and one of them was appointed to exercise a potent influence on the destiny of millions of the human race, for it was eventually to lead up to the discoveries of Jenner. They were not printed till after her death, in 1762. The one which at last led to the establishment and popularization of inoc-

ulation for smallpox was written from Adrianople in 1717 to her friend Miss Sarah Chiswell. The passage relating to inoculation is here given entire: "Apropos of distempers, I am going to tell you of a thing that I am sure will make you wish yourself here. The smallpox, so general and so fatal among us, is entirely harmless here by the invention of *ingrafting*, which is the term they give it here. There is a set of old women who make it their business to perform the operation in the month of September, when the great heat is abated. People send to one another to know if any of their family has a mind to have the smallpox. They make parties for the purpose, and when they are met—commonly fifteen or sixteen together—the old woman comes with a nutshell full of the matter of the *best sort of smallpox*, and asks what vein you will please to have opened. She immediately rips open the one that you offer to her with a large needle, which gives you no more pain than a common scratch, and puts into the vein as much venom as can lie upon the head of her needle, and after, binds up the little wound with a hollow bit of shell, and in this manner opens four or five veins. The Grecians have commonly the superstition of opening one in the middle of the forehead and in each arm and on the breast, to make the sign of the cross; but this has a very ill effect, all the wounds leaving little scars, and is not done by those that are not superstitious, who choose to have them in the legs or in that part of the arm that is concealed. The children or young patients play together all the rest of the day, and are in perfect health till the eighth; then the fever begins to seize them, and they keep their beds two days, very seldom three. *They have very rarely above twenty or thirty in their faces, which never mark;* and in eight days' time are as well as before their illness. Where they are wounded there remain running sores during their distemper, which I doubt not is a great relief of it. Every year thousands undergo this operation, and the French ambassador says that they take the smallpox here by way of diversion, as they take the waters in other countries. There is no example of any one has died in it, and you may well believe I am very well satisfied of the safety of the experiment since I intend to try it on my dear little son. I am patriot enough to take pains to bring this useful invention into fashion in England, and I should not fail to write to some of the doctors very particularly about it if I knew any of them that I thought had virtue enough to destroy such a considerable part of their revenue for the good of mankind. But that distemper is too beneficial to them not to expose to all their resentment the hardy wight that should undertake to put an end to it. Perhaps if I live to return I shall have the courage to war with them. Upon this occasion admire the heroism in the heart of your friend."

Macaulay has this eloquent passage on this disease when describing the miseries of the old times: "Smallpox was always present, filling the churchyards with corpses, leaving in those whose lives it spared the hideous traces of its power, turning the babe into a changeling at which the mother shuddered, and making the eyes and cheeks of the betrothed maiden objects of horror to her lover." No wonder that the Lady Mary underscores the part which says it leaves no mark—a womanly touch for which we love her.

She had Mr. Maitland, surgeon to the embassy, procure variolous matter from a suitable subject, and a very experienced old Greek woman was employed to insert it; she inoculated one arm and Maitland the other; the disease ensued in due course, with the production of about a hundred pustules. This was the first time that the Byzantine method was employed on an English subject.

Mr. Montagu was attending to his ambassadorial duties at Belgrade at the time, and she wrote to him on March 23, 1718: "The boy was ingrafted last Tuesday, and is at this time singing and playing, very impatient for his supper; I pray God my next may give as good an account of him. I can not ingraft the girl; her nurse has not had the smallpox." Persons who have smallpox by inoculation impart it to others just as if they had acquired the disease in the natural manner, but we may be quite sure that the little lady was submitted to the operation that would preserve her beauty as soon as possible after she was weaned. Her husband being politically promoted, they returned to England after having lived in Turkey but little more than a year, and Dr. Maitland at once endeavored to establish the practice in London, being enthusiastically seconded and supported by her. Not till 1781, as its expediency had been agitated by scientific men, was an experiment sanctioned by the College of Physicians and allowed by Government. Five persons condemned to death willingly encountered the danger, with the hope of life. Upon four of them the eruption appeared on the seventh day; the fifth was a woman on whom it never appeared, but she confessed that she had had the disease when an infant. Lady Mary strove so earnestly to introduce the practice among mothers of her own rank in life that we learn from her letters that much of her time was given up to consultations and superintending the success of her plans. Steele, in his Plain-Dealer of July 3, 1724, wrote of her: "It is an observation of some historian that England has owed to women the greatest blessings she has been distinguished by. In the case we are now upon this reflection will stand justified. We are indebted to the reason and courage of a lady for the introduction of *this art*, which gains such strength in its progress that the mem-

ory of its illustrious foundress will be rendered sacred by it to future ages. . . . She consecrated its first effects on the persons of her own fine children; and has already received this glory from it that the influence of her example has reached as high as the blood royal. It is a godlike delight she must be conscious of when she considers the many thousands of lives that will be saved every year after the general establishment of the practice—a good so lasting and so vast that none of those wide endowments and deep foundations of public charity that have made most noise in the world deserve at all to be compared with it." To understand how great the deliverance was, it should be known that then it killed one in seven of all that were born; it caused about one third of all the blindness in those pitiable victims, and it disfigured multitudes frightfully. Mrs. Croasdale, an English lady born early in this century, mentions in a recent book of reminiscences that in her childhood so many were "pitted" that a person with a smooth face was notable.

Notwithstanding this eulogy from a highly intelligent source, it is pretty certain that, like all those persons who are overmasteringly possessed with one idea, she was considered an unreasonable "crank." The very friend to whom she wrote the minute description of the process died of smallpox; and the Lady Mary's sister, Lady Mar, had that most precious of English aristocratic possessions—an only son. She offered to inoculate him, and promised to take him into her own house and care for him personally till he should be recovered; but the sister failed to be convinced, and the boy died in childhood of the disease.

People still remained so skeptical that Lady Mary used to take her little daughter into houses where people had been inoculated, and whose convalescence she was superintending, to prove her own immovable conviction of it as a protective measure.

At one time such unreasonable prejudices were excited that clergymen and physicians became violent anti-inoculators. Pamphlets appeared in which it was described as the outcome of "atheism, quackery, and avarice"; it was denounced from the pulpit as "an impious interference with the just and inscrutable visitations of God"; and Dr. Wagstaffe, of St. Bartholomew's Hospital, said that "posterity would marvel that a practice employed by a few ignorant women, among an illiterate and unthinking people, should have so suddenly been adopted by one of the politest nations in the world." That this was a narrow and unmerited piece of severity is shown by the facts that these "unthinking" people had discovered that there is a difference in the features of the disease in different cases—hæmorrhagic, confluent, discrete, etc.; that those artificially produced follow closely the character of the cases from which they are planted, each yielding "seed

after his kind"; that it is important to have the system in a healthy condition, which they tested by making a slight wound, and if it healed kindly and normally, they concluded that the inoculation would come out all right; they chose the most favorable month of the year, and they isolated, not individuals, but parties, for, as the Turks were not a reading people, we can imagine that social aggregations saved them from the *ennui* of sickness and convalescence. After the practice was introduced among the "politest peoples," some serious disasters came from neglecting the precautions that had been found absolutely essential to oriental success. As to the "sudden" adoption: in spite of her enthusiastic advocacy, it was not till fifty years after Lady Mary's children were inoculated that the practice became established in her native land, and then not till the Princess of Wales, having had some charity children operated on to satisfy herself of its safety, caused her sons to be inoculated, thus giving that royal sanction so needful there to make a thing "go." Having thus acquired the royal stamp, the College of Physicians formally indorsed it. No less than eighteen individuals had died in Lord Petrie's family alone, in the twenty-seven years preceding 1762, and among the royal families of Europe fifteen persons had perished within the compass of a single year.

The Lady Mary resided in Italy for twenty-two of the later years of her life, returning to die of cancer in 1762, aged seventy-three. In the cathedral at Litchfield a cenotaph is erected to her memory bearing this inscription:

"SACRED TO THE MEMORY OF
THE RIGHT HONORABLE
LADY MARY WORTLEY MONTAGU,
WHO HAPPILY INTRODUCED FROM TURKEY
INTO THIS COUNTRY
THE SALUTARY ART
OF INOCULATING THE SMALLPOX.
CONVINCED OF ITS EFFICACY
SHE FIRST TRIED IT WITH SUCCESS
ON HER OWN CHILDREN
AND THEN RECOMMENDED THE PRACTICE OF IT
TO HER FELLOW-CITIZENS.
THUS BY HER EXAMPLE AND ADVICE
WE HAVE SOFTENED THE VIRULENCE
AND ESCAPED THE DANGER OF THIS MALIGNANT DISEASE.
TO PERPETUATE THE MEMORY OF SUCH BENEVOLENCE
AND TO EXPRESS HER GRATITUDE
FOR THE BENEFIT SHE HERSELF RECEIVED
FROM THIS ALLEVIATING ART,
THIS MONUMENT IS ERECTED BY
HENRIETTA INGE—
RELICT OF THEODORE WILLIAM INGE, ESQ.,
AND DAUGHTER OF SIR JOHN WROTTELSEY, BART.,
IN THE YEAR OF OUR LORD 1789.

The monument itself is a mural marble, representing a female figure of Beauty weeping over the ashes of her preserver, supposed to be inclosed in the urn inscribed with M. W. M. intertwined in

Lady Mary's cipher. In the literary remains of the time, the fact that she had preserved the *beauty* of her countrywomen is mentioned ten times to one of the preservation of life.

Lady Mary's thoroughly intelligent account of the process shows that in her case the new idea had fallen into a hospitable and enlightened mind, and although she did not live to see the fruition of her efforts in the immense amelioration of the condition of her countrymen that took place later, there was wrapped up in the process she had naturalized the germ of a mighty fact of biology destined to spring up and bear a myriad of those leaves that are "for the healing of the nations." When the value of the operation was thoroughly appreciated there came upon the scene some enterprising doctors who established what they called "inoculation houses"—we should say now smallpox sanitariums—for isolation was needed to preserve the community, as the disease communicated itself as surely through voluntary sufferers as when it had been taken unwittingly. Here the candidate was put through a course of medication that to-day seems nothing less than ferocious; and one doctor—Dimsdale—rendered himself so conspicuous as to be knighted, and the Empress of Russia sent for him to inoculate herself and her son Paul. The bold experiment was first tried on two young gentlemen of the cadet corps, and afterward, a second experiment was made on four more cadets, before royalty ventured. Then the exalted candidates passed safely through it, and Dimsdale says, "the Empress and the Grand Duke were pleased to permit several persons to be inoculated from them, and by that condescension the prejudice which has reigned among the inferior ranks of people that the party would suffer from whom the infectious matter was taken was most effectually destroyed." Dimsdale was made Baron of the Russian Empire and physician to her Imperial Majesty, and awarded ten thousand pounds in addition to an annuity of five hundred pounds. As up to this time every seventh child born in the Russian Empire had died of smallpox, the royal conduct is to be commended.

A careful sifting of all the methods and recorded experiences of all the inoculators shows that the essential vital kernel of the process grazed closely on Pasteur's "attenuated virus," and that all their "cooling" and "dieting" and "strengthening" sank into insignificance beside the one dominating point of using a *benign* virus, if such a contradiction in terms is allowable. Much valuable knowledge in reference to inoculation was accumulated, and some brilliant foreshadowings of modern knowledge as to the way in which infection spreads were seen, but these discoveries were soon to be thrown into eclipse by those of Edward Jenner.

This great benefactor of humanity was born in Berkeley, in Gloucestershire, in 1749, and at the time of Lady Mary Montagu's

death was thirteen years old, but he already had evinced a strong taste for natural history—had begun an orderly and well-kept cabinet of new and original specimens, and had formed the valuable habit of recording in a note-book his observations on physical phenomena. His father had died when he was six years old, but he was reared with great care and tenderness by an elder brother, who, perceiving his strong natural bent, apprenticed him to a surgeon, with whom he diligently studied and worked till he was twenty-one, when he went to London to become the pupil of the celebrated John Hunter, in whose family he lived for two years. Hunter had a large private menagerie at Brompton, where he solved for himself some important questions in physiology. Jenner, filled with admiration at the large and unselfish way in which Hunter pursued knowledge for its own sake, formed a friendship for his great master that ceased only at Hunter's death, whose letters to Jenner are among the most interesting extant.

While yet a surgeon's apprentice, before he went to London, he had written in his note-book that he had heard a milkmaid say "she could not have the smallpox as she had had cow-pox"; and the Duchess of Cleveland, when taunted that she might lose her beauty, had replied, "I have no fear of that, for I have had a disease that will save me"; and he was familiar with the general tradition in the dairies of Gloucestershire that those who had contracted cow-pox from the cows would never have smallpox. The thought came to him, *Can this virus be inserted voluntarily in the human subject?* He mentioned his speculations on the subject, that was even then taking a firm hold on his mind and inexorably marking out his *rôle* in life, to Hunter, who listened with interest, thought they were "curious," but was too much absorbed by his own engrossing themes to more than repeat his famous instruction, "Don't think, but try." That the new idea in biological science that was to rescue millions from premature graves came to a trained intelligence is further shown by the fact that, while Hunter's pupil, Jenner had been employed to prepare and arrange the valuable zoölogical specimens brought back by Captain Cook's first expedition in 1771, and did the work so acceptably as to be invited to accompany the second expedition as naturalist—an honor which he refused, preferring to return to his country home and engage in the practice of his profession near the brother to whom he was devotedly attached; and those who believe in the "destiny that shapes our ends" will say, where he could study the mysteries of cow-pox in its native haunts. He soon had a large practice, and he formed a society of the medical men of his vicinity—they discussed medicine first and dined afterward—Jenner contributing his full share both of the solid work and the fun. Hunter wrote him, "I am very happy that some of you have wished to commu-

nicate your ideas to each other." On these occasions he would often bring forward his suspicions on the subject of the relations of small-pox and cow-pox—a theme that was taking commanding possession of his mind. His medical friends treated his ideas with indifference, or brought forward instances that militated against his theory; called him a "dreamer"—how often "Behold this dreamer cometh" greets advanced ideas!—and finally they began to consider him a bore, and threatened to expel him if he did not cease to trot out his hobby. Meantime, while not neglecting his practice, and while following up many lines of physiological and pathological investigation, he continued to collect all the facts and observations, and what other people thought counter facts, that had a bearing on the relation between cow-pox and small-pox; and in 1788 carried a drawing of the cow-pox, as seen on the hands of a milkmaid, to London, and showed it to Sir Everard Home, the President of the College of Surgeons, to convince him of the identity of the two diseases. Sir Everard condescended to assure him that "it was a curious and interesting subject."

Owing to the rarity of the disease in the dairies, or to its concealment, for which there was a strong motive, it was a long time before he found an opportunity of testing his theories by experiment. On the 14th of May, 1796, he took lymph from the hand of a dairymaid who had caught the disease in milking, and inserted it by two superficial incisions in the arms of James Phipps, a healthy boy about eight years old. He passed through the disease in a regular and satisfactory manner, but the most anxious time was yet to come; it was necessary to show that the boy was proof against the *contagium* of smallpox. In the following July this was settled, for variolous matter taken directly from the pustule was inserted by several incisions, but no disease followed. He wrote to the friend, Mr. Gardner, in whom he had always confided his hopes, "You will be gratified in hearing that I have at length accomplished what I have been so long waiting for: the passing of the *vaccine virus* from one human being to another by the ordinary mode of inoculation." After minutely detailing the process, he adds, "I shall now pursue my experiments with redoubled ardor." It was now twenty-five years since he had mentioned his "suspicions" to Hunter, a fact to be remembered when, afterward, he was rebuked by pompous arrogance in the person of Dr. Ingenhousz, for too hastily rushing into print, which he did not do till he had collected twenty-three cases, all of whom had passed through vaccination successfully, and had been tested subsequently by the inoculation of variolous virus and shown to be proof against it.

This was the high tide of happiness in Jenner's life—he was under a great degree of mental exaltation, although he maintained

his humility and disinterestedness. In writing of this period he says, "While the vaccine discovery was progressive, the joy I felt was at the prospect before me of being the instrument destined to take away from the world one of its greatest calamities."

What he really accomplished during those twenty-five years of preparation and waiting is, succinctly, as follows:

1. He perceived that some profound modification of the effects of the virus of smallpox occurred when it was introduced through a puncture in the skin, instead of finding its way to the system through the natural channels of the lungs and the stomach.

2. That cow-pox was really smallpox in cows,* but that the disease in passing through the tissues of that animal underwent a still greater modification, by which its period was lessened, and that it became non-contagious, unless a person brought in contact with it had some abrasion of the skin.

3. That persons who had accidentally acquired it from the cow did not give it to others while passing through it, and were henceforth secure from attacks of smallpox.

It was his putting of "this and that together" that made the great step forward: could this modified virus be inoculated successfully into the human system as smallpox had been; and, if so, would it protect against smallpox? James Phipps had furnished the triumphant answer, and his other twenty-two cases had confirmed its truth. He did not find a second opportunity for putting his hypothesis to the test till 1798; he then repeated his inoculations with the utmost care, and prepared his book for printing. Before giving his work to the press, he devoted the most solemn and conscientious care to it, reading it sentence by sentence to a few of his most intimate friends and asking for their unsparing criticism. Its title was, An Inquiry into the Causes and Effects of the Variolæ Vaccinæ (Cow-pox). These friends saw in it a great victory of the sagacity of man over one of the most fatal of diseases, and they urged him forward in his purpose of opening for the benefit of all "the stream of life and health he had been permitted to discover"; in their enthusiasm they said "he seemed to hold in his hand one of the gates of death, with power to close it." In addition to the great fact that constituted the vital kernel of his discovery, he had incidentally learned much besides. He was convinced that there were two similar-appearing diseases affecting cows that could be imparted to man, one of which he named "spurious," and which afforded no protection against smallpox. He also learned that there were rare cases where per-

* An opinion confirmed by an account of experiments published in *La Semaine Médicale*, December 31, 1890, made by Elternod, of Geneva; Haccius, the Director of the Vaccine Institute of Lancy; and of Dr. Fischer, Director of the Vaccine Institute at Carlsruhe in Germany

sons had had a second attack of smallpox, and that there were cases where people who had acquired what they thought cow-pox in the natural manner had been attacked by smallpox later. He set himself to study these anomalies, and became convinced that there is one "right," strictly limited time for taking the vaccine virus, and that matter taken later will produce a pustule and severe illness, but affords no protection. Also, he learned that there is a right and a wrong way in which to insert the virus—in short, that the operation is a nice exercise of medical art. He discovered that certain eruptive diseases occurring at the same time make the best virus inoperative, and he ascertained that there are many circumstances that rapidly destroy the vitality of the virus when not properly cared for. He left the fruits of all these observations embodied in a set of rules of procedure that nearly a century of experience and medical advance has not improved upon. Of course, he could not foresee the wonderful evolution in the methods of the production of the virus that now puts such a large and safe supply into the hands of the practitioner.

We, who tranquilly enjoy the fruits of the great deliverance from the horrible and universal plague of smallpox, see and know so little of it as not to be able to form any just conceptions of the monstrous proportions of the scourge when unchecked. The average death-rate from it throughout England was such that if applied to the present population it would give 70,000 per annum; in London alone before 1804 the annual deaths were 2,018 in a population of a million; in 1890, in a population of four millions there was just one death from smallpox. In the year 1886 there was not a death from it in Massachusetts.

Jenner went to London in April, 1798, intending to bring out his book and illustrate his doctrines on the spot. He was prepared with a pure and efficient virus that had been already tested, but to his surprise and chagrin, although he was known in the highest medical circles as a man worthy of undoubted credit and of thoroughly established scientific repute, he could not find one individual willing to submit to the operation. His pamphlet—a quarto of seventy pages—was published on June 21, 1798. Seldom has a book appeared fraught with greater consequences to mankind. When he went home he left some virus in the hands of a friend—Mr. Cline—who at the end of July inserted some of it by two punctures on the hip of a child who had hip disease, under the notion that the counter-irritation produced by it might cure the trouble. It made no difference with the original disease, but by a thorough inoculation afterward with smallpox virus the child was found proof against that disease.

When the book had had time to make its due impression, with its thoroughly wrought-out and carefully written-out series of

twenty-three cases, the most advanced minds among doctors at home, as well as in all the capitals of Europe, were hospitable to the discovery and perceived the immense benefits likely to flow from it. On the 27th of November, 1798, Jenner vaccinated two children of a Mr. Hicks with lymph taken from a farm at Stonehouse, this gentleman being the first private subject to allow the experiment on his children.

Lady Ducie was the first person of rank who gave tangible support to the practice by having her only child vaccinated. No better comment on the better day in which we live exists through the diffusion of knowledge by the newspaper press, daily recording the discoveries of scientists, than the audacious attempt made in London to supplant Jenner, which came near being successful, and during its progress beclouded his discovery and caused him great anxiety, notwithstanding which the story of the triumphant adoption of the practice in all the enlightened countries of the earth reads like a fairy tale. Monarchs honored him, decorations and gifts were showered upon him, and, in the height of his joy, there was not wanting the one black drop to keep him humble and sober, in the existence of a knot of anti-vaccinationists whose pestilent successors are not yet vanished from the face of the earth, though very recently towns in which their influence has ruled have been scourged with smallpox. At this juncture he wrote to his friend Gardner: "At present I have not the most distant doubt that *any person who has once felt the influence of perfect cow-pox matter would never be susceptible of smallpox*, but on the contrary, when the disease has been excited by the matter of cow-pox in an imperfect condition, the specific change of the constitution necessary to render the contagion of smallpox harmless is not produced; and in this point of view there is a close analogy between the propagation of the cow-pox and the smallpox. Therefore, I conceive that it would be prudent, until further inquiry has thrown every light on the subject that it is capable of receiving, that—like those who were the objects of my experiments—all should be subjected to the test of variolous matter who have been inoculated for smallpox."

Another circumstance of a different sort at times tried Jenner's accurate and scientific soul. He had vaccinated thousands gratuitously, and taught many persons to perform the operation correctly; clergymen and noblemen and women learned to perform the operation, strictly according to his instruction, and applied their knowledge on thousands of the people dependent upon them with perfect success; but doctors, wise in their own conceit, caused every now and again disaster, by not being careful enough about the exact "right time" to take the lymph in the arm-to-arm practice that had generally disseminated itself.

Still, he had the satisfaction of seeing compulsory vaccination established in many of the countries of Europe, and knew that it was making its way among enlightened peoples everywhere, before his death in 1823, which occurred in his native rural home, where he had returned after a short and distasteful residence in London. Ten days before his death he got a letter, on the back of which he wrote the following: "My opinion of vaccination is precisely as it was when I first promulgated the discovery. It is not in the least strengthened by any event that has happened, for it could gain no strength. It is not in the least weakened, for if the failures you speak of had not happened, the truth of my assertions respecting the coincidences which occasioned them could not have been made out."

In the seventy years since, evidence has accumulated as to the inestimable value of the original discovery; wide observations among thoroughly trained medical men have also demonstrated the value of revaccination—after maturity—of persons who had been vaccinated in infancy; but the most glorious result of all was to be the illumination of Pasteur's great scientific mind, as to the possibility of the production of a modified virus in other diseases than smallpox.

Modern science contains no more interesting chapter than the one which shows how that, after the achromatic compound microscope—magnifying close on to two thousand diameters—was put into the hands of scientists, step by step it was shown that what we call zymotic or "catching" diseases are caused by the living germs of parasitic plants entering the blood, and there multiplying and growing, deriving the needed sustenance from the blood itself. Pasteur caught the idea of a modified growth from Jenner's experiments, as he distinctly said in his original paper on anthrax, read before the French Academy. That it is within the power of man to modify plants outside the body, any one who has tasted a native astringent crab and a delicious Baldwin apple will believe, but it remained for a devotee of science for its own sake—like Pasteur—to observe and experiment and think till he achieved that "attenuated virus" which annually saves millions of animals in Europe from the ravages of anthrax, and multitudes of men from death by hydrophobia through the bites of wolves, dogs, and cats. The statistics of the Pasteur Institute of Paris show that in the five years from January 1, 1886, no less than nine thousand four hundred and thirty-three persons were treated, of whom fifty-eight died, or 0·61 per cent. The instrument of this merciful exemption was a modified—i. e., attenuated—virus.

With such results, such victories of the wit of man over Nature, while bacteriology is yet in its early infancy, it is no wonder that Pasteur predicts the time when "these diseases will be

made to disappear from the face of the earth"; and as a fine example of the way in which mind kindles mind, we will cite the way in which Pasteur's study of *pébrine* in silkworms, and his formulation of the germ theory of disease, put into Lister's hand the true key to the havoc of bacteria in wounds, and enabled him to lay the foundation of modern antiseptic surgery which annually saves its thousands from death.

He noted that when a man broke a rib he had no "surgical fever," but made a safe and rapid recovery, unless the bone had penetrated the lung, when he died of pneumonia; but that other surgical wounds behaved very differently—that some exterior substance got into them; and Pasteur's studies taught him what was the element of mischief, so that we are justified in drawing out a certified pedigree as follows:

It was Lady Mary's observation of the difference in its consequences whether that which she called "matter," but which we now know to be the infinitesimal seeds of microscopical plants, came into the human system unconsciously through the lungs and stomach, or whether it was deliberately inserted artificially, of course making its way through the lymph-channels, that led Jenner to ask himself whether the seeds of the disease as modified by passing through the tissues of the cow might not also be inserted artificially. Fifty years after his death Pasteur, inaugurated the science of "microscopical botany," and had convinced himself that all the contagious diseases are the result of parasitic growths, and in his original papers, read before the French Academy, says he was put upon thinking whether the Jennerian application of a modified, "attenuated," less virulent virus could not be made in other diseases by the success in vaccination, and like a true knight of science he did not rest till he had produced and used such a remedy, saving millions of animals annually from the ravages of anthrax and thousands of men from hydrophobia. Continental flocks and herds are now as regularly "inoculated" as our children are vaccinated, but the greatest result of all is Lister's establishment of what is known as antiseptic surgery. In the thousand laboratories where splendid work for humanity is to-day progressing a picture of the Lady Mary, as inspiring genius, ought to be hung up; and it certainly is pleasant to the wide-awake women of the last decade of this nineteenth century to find, as we follow the unbroken chain backward, its first link in the delicate hand of an intelligent and courageous woman who dared to confer a priceless benefit, at the risk of obloquy, in the first quarter of the last.

JOSEPH NEEF: A PESTALOZZIAN PIONEER.

By A. CARMAN.

THE Hon. George S. Boutwell, in the November number of The Popular Science Monthly, referred to a recent article by Prof. W. W. Aber on the Oswego State Normal School, in which is claimed for that school the credit of introducing into this country the Pestalozzian system of teaching. The Oswego School was founded in 1853, and Mr. Boutwell says that from about the year 1839 this "art of teaching was taught" in the Massachusetts State Normal Schools.

While the first schools for teachers of the Pestalozzian system may have been in Massachusetts, Pennsylvania may yet claim the credit of having the first Pestalozzian school for children in America. It was established in 1809 by Joseph Neef, at a spot then called the Falls of the Schuylkill, some four miles from the old city of Philadelphia, now part of Fairmount Park.

FRANCIS JOSEPH NICHOLAS NEEF was born in Soultz, Alsace, December 6, 1770. He was educated for the Roman Catholic priesthood, but at the age of twenty-one, when about to take orders, he gave up the idea of entering the Church, as not being at all suited to his tastes. He entered the French army under Napoleon, attaining high rank therein, and in the battle of Arcola was severely wounded in the head by a spent ounce ball, which he carried to the day of his death, a period of over fifty years. After leaving the army he became teacher of languages in Pestalozzi's celebrated school at Burgdorf, Switzerland, where he remained for some years, being then sent by Pestalozzi to Paris at the request of a philanthropic society whose attention and interest had been at tracted to the good work being done at Burgdorf.

During Neef's stay in Paris, Mr. William Maclure, an American patron of education, science, and philanthropy, visited Pestalozzi's school, which had by that time been moved to Yverdun. Mr. Maclure was so favorably impressed by the rational methods employed in this school that he conceived the generous idea of establishing a similar institution near Philadelphia, where he was then living. Pestalozzi recommended to him his former coadjutor, Joseph Neef, as a man thoroughly imbued with his principles and well fitted to introduce them into the Western world. Neef, when approached on the subject, hesitated, for, though master of eight languages, he was ignorant of the English. Persuaded, however, that he could soon overcome this difficulty, he came to America, and such was his success that within a year he published a work of one hundred and sixty-eight pages in the English language, with the following descriptive title: Sketch of a Plan and Method

of Education founded on an Analysis of the Human Faculties and Natural Reason, Suitable for the Offspring of a Free People, and for all Rational Beings. By Joseph Neef (formerly a Coadjutor of Pestalozzi, at his School near Berne, in Switzerland). Philadelphia, 1808.

This work is faultless as to grammatical construction, and was the first strictly pedagogical work published in the English language in this country. It would interest any modern teacher who has read the numerous pedagogical works of to-day to give this quaint little volume a careful perusal. There are now but half a dozen known copies in existence, one being in the State Library at Indianapolis. Another work, Method of Teaching Children to Read and Write, was published by him in 1813.

Neef had in the school established at the Falls of the Schuylkill about one hundred pupils, most of them boarders, who were taught physiology, botany, geology, natural history, languages, mathematics, and other branches, without the aid of a single textbook, a purely natural method being followed. "Neef's boys from the Falls," as they were known to Philadelphians, could, without exception, after being in the school for a short time, work mentally the most difficult examples in arithmetic, converse with equal ease in several languages, and many who were his pupils have said in after years that the amount of scientific information and practical knowledge gained while under Neef's care had always been of incalculable benefit to them.

In 1813 he removed to Village Green, in Delaware County, Pennsylvania. David Glasgow Farragut was one of his pupils at this place. From here the school was moved to Louisville at the earnest solicitation of several Kentucky patrons. In 1826, when Robert Owen, of New Lanark, Scotland, began his famous socialistic experiment at New Harmony, Indiana, Mr. Neef took charge of the educational department of his community. In 1828 the community ceased to exist, and Mr. Neef removed to Cincinnati, and later to Steubenville, Ohio, where he engaged in his last school. He died at New Harmony in 1853.

The following extract is taken from his book published in 1808: "The man of refined morality feels it to be his duty not only to be good, but also to inquire in what situation and through what means he may be able to produce the greatest sum of good to his fellow-creatures. It is my ambition and duty to become a useful member of society. The education of children and the rearing of vegetables are the only occupations for which I feel any aptitude. I have, therefore, seriously inquired in which of these two spheres I should produce the greatest advantage to the society of which I may become a member, whether by clearing and tilling some secluded spot of land, or by cultivating the

pretty bewildered field of education. After mature deliberation I became fully convinced that in the latter capacity my faculties will be more likely to be beneficial to my fellow-creatures. These are my reasons for appearing as a teacher, or rather educator."

Mr. Neef left no male descendants, but two married daughters are still living in this country.

KILN-DRYING HARD WOOD.

By O. S. WHITMORE.

AMONG the many changes that have taken place in the manufacture and handling of lumber, there is none more marked or interesting than in the method of preparing lumber for use by getting rid of its natural or acquired moisture. For a century and a half after sawed lumber came into use, none but natural means were used for drying it, preparatory to its consumption in the building and kindred arts. Even in comparatively modern times, when sash, doors, and blinds were made by hand, and flooring and ceiling were dressed and matched in the same manner, if a person concluded to build some time in the future, the stock for these purposes was often bought after being weather-dried as much as possible and stored away in barns, lofts, and garrets, where it was not seldom left for years.

There can be no denying that this stock made excellent work, though it became not infrequently discolored from want of a circulation of air, which fact became so well understood that when at last attempts were made to shorten the drying period by artificial means, they all embodied some attempt, more or less crude, to create a circulation, to the end that the air that had enveloped the lumber until it had absorbed a portion of the moisture should be thrown or forced out of the drying room or building.

The first attempts at artificial drying did not contemplate general stock or drying lumber for shipping, the first dry-houses being usually nothing more than a one-story frame structure built over a low cellar excavated in the side of a hill, with a slatted floor above and a latticed cupola on the roof. A brick or tile furnace or arch was built in the cellar, from which extended a number of sheet-iron pipes which, while conveying the smoke to the chimney, also acted as radiators. The furnaces were built so as to be stoked from the outside through an arch in the wall on the down-hill side. After the introduction of cast-iron stoves, they were often substituted for the brick or tile furnaces, and in some cases these in turn were superseded by wrought-iron cylinders like steam-boiler shells.

The material to be dried was stacked upon the slatted floor in loose piles, through which the heated air from below could circulate more or less freely. For years these dry-houses—they were not then dignified by the name of kilns—were only used in connection with certain manufactories for drying stock already cut up for tubs, pails, and other wooden ware; small boxes, chairs, and other furniture material; turned work and Yankee-notion stock in general; no regular lumber stock being subjected to the process.

Occasionally a little lumber for interior finish, where an extra fine job was desired, was run through the dry-house for a final drying, and later, after machine-made sash, doors, and blinds began to take the place of the old hand-made goods, being generally made from air-dried stock, they were sometimes put through the dry-house before being wedged and pinned.

These dry-houses contained such an element of fire risk that they were generally built in isolated positions as close to water as possible. Even then they were a constant menace to all surrounding property as well as to their own contents. Lumber, except in small pieces, dried in them was apt to be checked and warped or twisted more or less, and was not at all satisfactory save in the one feature of being free from moisture.

The fire risk at last became so great where the establishments requiring the dry-houses were situated in towns, and the restrictions of underwriters so onerous, that along in the fifties some crude attempts were made to substitute steam for the furnaces by conducting the exhaust from the engines running the works into the cellars.

It is not definitely known when or by whom the first attempts were made, but it is a fact that as early as 1855 the trial was made by a manufacturer in northern Massachusetts. But the experiment did not prove very satisfactory, for the reason that the steam had to be carried quite a long distance; the science of protecting steam pipes so as to prevent condensation was not as well understood as at the present day; the engine was none too large and the boiler capacity limited, and there was more or less back pressure.

But so certain were the experimenters that they were on the right road that they kept up the trials, though, from causes stated, making but little attempt to use the steam during the winter months. Success seemed near, when the panic of 1857 came on, and the house met with reverses that stopped all further experiments. Some additional attempts were made in the New England States during the next four years, but in a rather desultory way, when, the war of the rebellion coming on, the inventive genius of the country seems to have been turned in

other directions and the subject of drying lumber slept for some years.

A patent was granted to Hannah and Osgood, November 27, 1866, for "an improvement in the method of drying lumber," and other patents followed in rapid succession, a full history of which is shown by the records of the Patent Office. But it does not appear that any really successful kiln was built until the year 1875, when one was erected at Stillwater, Minn., and a little later one in Chicago, if the records are correct, for Pond and Soper, though Turner Brothers had one built about the same time. The dates as to when the first steam drier was put in successful operation are a little foggy, claims being made both for Stillwater, Minn., and St. Albans, Vt.

The question of the artificial drying of hard-wood lumber has assumed such importance that all, both manufacturers and dealers, must be interested in the subject. To air-dry hard-wood lumber by simple, natural means involves the loss of interest on immense sums of money invested in the lumber while it is awaiting the slow and not always satisfactory or sure process of Nature; while, on the other hand, it is a well-admitted fact that unscientific and hence unskillful drying by artificial means often involves a loss greater than the other.

The earliest attempts at the artificial drying of lumber made no difference in the matter of varieties of wood or quality of stock. All kinds and qualities were run in promiscuously, and all subjected to the same treatment. The only theory acted upon was that the lumber, being green or wet, must be dried in the shortest possible time. To effect this result it was only thought necessary to create as great a heat as possible within the limits of safety, and to raise it to the maximum degree in the very shortest time, the limit being often raised to a reckless height, not infrequently reaching the point of actual partial carbonization to an extent that killed the life of the lumber so treated. Often the kiln would be hastily opened for the removal of dry stock, while it was under full headway, with the heat up to the highest point, and green and often frozen lumber hurried in to receive at the very outset a blast of heat as near the point of combustion as it was possible to raise it with any degree of safety.

This, of course, has reference more particularly to the days of dry hot air and furnace heat, though the same was true of the earliest attempts at steam heating. Nothing was known or thought of the effect of thus subjecting lumber to a high temperature at the very first stage of the drying process, and nothing was known of the effect of high temperature upon different varieties of wood or the same variety under different conditions, whether entirely green, or partially or wholly air-dried. One

thing only was known—that heat would drive the moisture, whether natural or acquired, out of the lumber, if it was only applied hot enough and long enough.

The physiology of wood, or what is now known as timber physics, was poorly understood by any one, much less by the men who were making the experiments; for in general they were plain business men, with only ordinary business education, and with no pretensions to scientific knowledge.

Thus little or nothing was known of the chemistry of woods and absolutely nothing of the effect of heat upon the gums, juices, or fibers. But while these men were not up in the sciences, they possessed what perhaps in this instance stood them in as good stead—hard common sense and quick perceptions, that permitted them to learn rapidly by experience and by quickness of observation to note the results upon the woods of various conditions in the course of their experiments.

Thus it was discovered, by a more or less costly experience, that in all the long list of varieties of timber hardly any two could be subjected to precisely similar treatment with the best results to both; and it was further found that difference in the source whence the same variety came often required a variation in treatment.

The next and perhaps the most important discovery made, and probably at the expense of the greatest amount of spoiled lumber, was that a temperature too high at the commencement of the drying process produced unsatisfactory results, and often ruined or greatly reduced the value of high-grade and costly material. Before this fact was discovered, so uncertain had been the process in its effects, other than in producing apparently dry lumber, that an actual prejudice arose against submitting upper grades to the artificial process until fairly weather-dried; it being found that if a portion of the moisture on and near the surface was evaporated by the natural heat of the sun, the effect of plunging the lumber at once into a high temperature when put into the kiln was less injurious.

Investigation and experiment proved further that this was a perfectly natural theory and one by which Nature herself worked constantly. It was fully and satisfactorily shown that lumber sawed and piled in the winter so as to take advantage of the first cool, dry days of spring, not only dried in better condition, with much less danger of sap stain, checking, and warping, but that it actually dried more completely to the very center of the piece, and in a shorter time.

This was found to be especially true of thick lumber, it proving to be a fact that, while the winter-sawed thick stuff would often, in favorable seasons, become remarkably dry to the very center,

stock of the same thickness, if sawed and piled during the months of extremely hot weather, would have to be carried over until the approach of another summer, the effect of the season of extremely damp atmosphere seeming to be to liberate the internal moisture, which somehow appeared to be imprisoned by some (at that time) unknown force, and which, being so liberated, was rapidly carried off by the cool, dry days of the following spring.

It had probably always been known that lumber would dry, and did dry, most rapidly during the season of high winds, but the fact had been generally accepted without asking for a scientific reason. But when it dawned upon the minds of the experimenters that there must be one, it led to the further discovery that air in motion of a low temperature would produce better results than air of a high temperature if kept stagnant, and that the ordinary atmosphere, with its natural temperature, if above the freezing point and with a low degree of humidity, if kept in constant motion or circulation, would dry lumber well and rapidly without the aid of artificial heat.

These points once definitely settled and understood, led to researches that immediately led into the domain of wood chemistry and physiology, and the experimenters and inventors became to a degree chemists and physicists. Thus a special education was obtained before they were able to say they had solved the problem of drying lumber artificially; fairly accurate knowledge on the following points being gained:

1. (*a*) Different varieties of wood, and (*b*) wood of the same variety grown in different localities, requiring radically different treatment.

2. (*a*) That too high a degree of heat applied at any stage, and (*b*) especially during the first, injured the lumber more or less, according to kind, and retarded or prevented perfect drying.

3. That with a perfect circulation of air of a low degree of humidity, a high temperature was not necessary to produce good results except as to time.

4. That the results, good or bad, depended very largely upon the chemical changes produced by heat upon the natural gums and juices of the wood.

5. That all these points became much more pronounced in the case of hard woods, and hence the necessity for special machinery and arrangement of the kiln.

THE calculation of the orbits of the newer asteroids has been greatly facilitated at Nice and Bordeaux, France, by astronomical photography, which makes it possible to follow them long enough to give a sufficient number of observations on which to base the computations.

ON ACQUIRED FACIAL EXPRESSION.

By LOUIS ROBINSON.

ALTHOUGH from infancy upward we are all, whether we know it or not, close students of physiognomy, and although a number of books, the result of much careful research, have been published upon the scientific aspect of the subject, there are certain facts connected with facial expression which, though often remarked upon, have never received explanation. With two of these—both of which bear upon the causes of acquired expression of a more or less permanent character—I propose briefly to deal in this article. I refer to the similarity of visage displayed by nearly all members of certain trades and professions; and to the likeness which often becomes apparent on the faces of people (generally married couples) who live together.

In addition to the bony framework, there are three chief anatomical factors which go to make up the expression of the face. These are the skin, the subcutaneous cushion of fat which contains the numerous blood-vessels, and, lastly, the facial muscles. The nerve supply is abundant and peculiar. The integument receives sensory branches from the fifth cranial nerve, the blood-vessels are under the control of the sympathetic system, and the muscles which have to do with expression receive motor impulses from the brain *via* the seventh cranial or facial nerve, first accurately described by Sir Charles Bell. It is to these numerous slips of muscular tissue, with their controlling telegraphic nerve fibers, that I wish especially to direct attention.

It is, of course, obvious to all who have an elementary knowledge of physiology that any movement of any part of the face is owing to the contraction of certain muscles, and that every such contraction must take place at the command of an impulse conveyed to the muscles by means of the motor nerves.

Into the historical evolutionary explanation of these movements it is not my intention here to enter. Let it suffice to say that there can be little doubt that they one and all represent some adaptation of the bodily structures to certain physical needs (possibly long obsolete) which accompanied the emotions of which the movements are now an index; just as the wagging of a dog's tail, which is now regarded as a mere sign of pleasurable excitement, was in the first place of vital importance as a signal to his comrades that game was afoot.

The connection between the muscles of expression and the emotional centers in the brain is of a most intimate character, and is largely independent of the will, although by strong volition any consequent movement of the features may generally be pre-

vented. That the association is instinctive, and not acquired through individual or racial education, is shown by the fact that the facial changes which accompany the sentiments of fear, hatred, contempt, merriment, or mockery are practically identical the world over.

The extreme rarity of the man who can always keep his countenance, even when his will is fully awake, is as complete a proof of this intimate and automatic bond between the mental apparatus and the facial muscles as need be brought forward. Are we not all aware of exercising a restraining effort upon our features when we endeavor to hide our emotions? And is not the common phrase, "He gave way to his feelings," a recognition of the fact that the invariable instinctive tendency is, when the emotions are stirred, to yield to those outward manifestations which are obvious to the eye of another, and which are the results of motor nervous impulse?

Now, this fact is most important in the study of what may be called "static physiognomy," which treats of the interpretation of habitual expression when the countenance is at rest. It shows that in all probability every emotion, however slight, sends an impulse to the appropriate muscles, although the immediate nervous provocation may be much too faint to produce any marked movement. That such trivial and evanescent nerve impulses, although their effect may be at the time unfelt by the subject himself and imperceptible to lookers-on, may be, if often repeated, efficient factors in the formation of a habitual cast of countenance, I shall presently show.

It is plain that such effects will become more perceptible when the first rotundity of youth has disappeared. We naturally look at a young face for a prophecy, and at an old one for a record. But the materials from which we attempt to inform ourselves are of a very different character in the two classes. In the one case we see a general arrangement of features, which, according to some utterly inscrutable law, accompanies certain traits of mental and moral character. No satisfactory theory has ever been put forward to account for such facts as that human beings with a certain inherited squareness of jaw are always of a tenacious disposition.

But when we scrutinize an older face, we peruse the linear inscriptions upon its surface as we read a book of which we know the author. Not only do such and such conformations of its lines have a definite meaning, but we can form an opinion as to why and when (if not *how*) they were written. The caligraphy, of course, is not uniform in all cases, and there are various complexities about it which may render an exact interpretation a matter of difficulty. Trouble or passion, which in one instance is

recorded in bold characters, in another may leave scarcely a visible mark; and it is obvious that a lean face will betray the story of emotional experience more readily than one covered with a mask of fat and smooth skin.

If we look at an anatomical representation of the human face with its integument removed, we see at once that the various groups of muscles are generally so arranged as to balance one another. Thus there is one set of muscles for opening the eyes or the lips, and another set for closing them; one group raises and another depresses the angles of the mouth, and so on. All these muscles, even when the features are quiescent, maintain a certain *tone;* for it is found that if one part of the face is paralyzed, the sound muscles near it draw it toward them and retain it there even when they are at rest. If one of the muscles or groups is stronger in proportion than its opponents, it will cause a marked change of expression, as is plainly seen in partial paralysis. It is a familiar fact that all muscles become larger and stronger through exercise; but the reason why they so increase is not such a simple matter. The vitality of muscular, and indeed of all other living tissue, is strangely under the influence of the nervous system. If the nerves which supply a limb are totally destroyed, it shrinks with extraordinary rapidity, although the main blood supply remains perfect. At the same time a limb may be paralyzed as to motion and yet undergo but little wasting, because certain nerve fibers (called *trophic*, because they have to do with nutrition) are left intact. In bedridden patients, again, in spite of a total want of exercise, the muscles often do not shrink in any great degree. Hence we see that nervous currents or impulses may influence the growth of a muscle apart from actual exercise.

Let us take an instance, the too visible results of which every one is familiar with. Persons who squint (with certain exceptions I need not here specify) are always "far-sighted"—that is, the convex lens of that marvelous living camera, the eye, is not quite convex enough; and in consequence its focus is too long to permit rays from a near object to form a clear image on the retina. If the retina could be pushed back away from the lens the difficulty would be overcome; but we can not, as in the case of an opera glass or a photographic apparatus, lengthen the space between the lens and the spot upon which the image is to be projected to any great extent, so Nature has provided a focusing apparatus in the crystalline lens itself. By a muscular effort the elastic lens can be made more convex, and in this way the focus is shortened to the required length. In long-sighted or flat-lensed persons this is constantly being done when they are reading or looking at some near object.

Now, it so happens that one of the little muscles which move

the eyeball—i. e., the *internal rectus*, which rolls the eye inward toward the nose—gets its nerve supply partly from the same source as do the muscles for shortening the focus of the lens. The latter, in far-sighted persons, are constantly being urged to action by impulses proceeding from the brain along the nerve, and part of the impulse invariably finds its way, owing to the intimate relation of the parts, to the *internal rectus* muscle. This muscle does not at first respond to the stimulus sufficiently to turn the eye inward every time the lens is accommodated for near objects; but the result of this nervous stimulation is in the long run the same as if the *internal rectus* were constantly called into action by a deliberate exercise of the will. It greatly increases in bulk and strength, and outpulls its opponent on the outer side of the eye (which gets its nerve supply from a different source), and so the balance of power is destroyed and a hideous inward squint is produced.

From this we can understand the effect of a long-continued dominant emotion on the face, even although it may exist in an individual too well bred to allow his countenance to be easily distorted by the prevailing passion. Whenever the thoughts take their habitual direction, a stream of nervous influence from the brain to the hidden-expression muscles is the inevitable concomitant. The closest observer may not notice the least change of outline or the vaguest tremor of movement at the time, and the subject himself may be unwarned as to what is going on. Yet in the course of years the muscles so stimulated assert themselves over the others, and a permanent expression in accordance with the mental character comes out.

Close observation of almost any face under favorable circumstances supports this view. While engaged in studying the phenomena of sleep, I have repeatedly noticed that the apparent placidity of the features during slumber is deceptive. Even in dreams each fleeting emotion affects the facial muscles in some degree, and the apparent calm on the surface covers many little eddies and currents beneath, as one or other of them is thus provoked into partial activity. When the thoughts are all-absorbing and the owner of the face is off his guard, it does not require a very acute observer to see how the expression follows what is in the mind.

The other day, while traveling by train, I witnessed the parting of a pair of lovers. The damsel got into the carriage where we were seated, and until the train started there was an eloquent interchange of glances and smiles. As we steamed off, the last smile of parting gradually faded on the lassie's face. She shut her eyes and leaned back, so that she did not see that she was under observation, and at the same time the light showed her

countenance with great distinctness. For the space of some twenty minutes, during which I was her fellow-passenger, the dimples of that parting smile would ever and anon appear, but in so slight a degree that, unless the opportunities for observation had been exceptional, they would not have been noticed. The movements of the muscles were so subtle that it was absolutely impossible to analyze them, or even to discern them severally. They were

> ". . . like the borealis race,
> That flit ere you can point their place."

Yet one could gauge from moment to moment the depth, and to some extent the nature, of her thoughts of her lover.

Let me strongly recommend all physiognomists who travel by rail not to spend their time in the perusal of text-books, while they have before them a row of living documents inscribed all over with the very aphorisms of the art. The opportunities for observation afforded by the British traveling hutch are such as to make one forgive its manifold inconveniences. Take the instance of the old lady who is perturbed about the safety of her ticket and her luggage. Her totality of expression has a heavy groundwork of care, upon which start and flicker endless additional lines, as this or that possibility of trouble crosses her mind. It requires some self-restraint on the part of the enthusiastic student to refrain from making such a one the subject of physiognomical research by hinting various moving hypotheses concerning the perils of the journey or the fate of her numerous packages. Let him not forget, however, that although such experiments are not forbidden by the Vivisection Act, the methods of Parrhasius are out of harmony with the spirit of the nineteenth Christian century.

The incessant flow of involuntary nerve-currents to the facial muscles doubtless accounts for the odd similarity of expression among men of the same vocation. In many such cases the conditions are so complex that it seems impossible to lay one's finger upon the special items of environment which conduce to the facial characteristics exhibited by nearly all members of certain trades and professions. What, for instance, is there about the process of making shoes which evokes the unmistakable cobbler's visage? The portrait of Edward, the Banff naturalist, in Mr. Smiles's book, shows the type in a marked degree. As far as my own observation carries me, the cause must be looked for in the last, lapstone, and wax-end of old-fashioned cordwainery; since men who work the machines in modern boot factories, or who do ordinary repairing, do not exhibit the expression. It appears probable that the tailor's distinctive type of face may have

been partially created by his habit of working his jaws concomitantly with his shears. Let any one watch a person cutting a piece of tough material with scissors, and he will see that the lower part of the face wags in rhythmic and spontaneous unison with the blades. Shepherds and farm laborers who join sheep-shearing gangs certainly acquire a different expression while engaged in this kind of work. The cast of countenance by which one so easily recognizes a groom is partially explicable from the fact that the muscles which close the jaw and compress the lips are always called into play when we are asserting our will over that of a horse. Nearly all jockeys and other horsey men have a peculiar set of the mouth and chin, but I have been unable to distinguish any special characteristic about the eye or upper part of the face. It is instructive to compare the visage of the ruler of horses with that of the ruler of men. The horseman's face shows command in the mouth, the drill-sergeant's in the mouth and the eye. The last is undoubtedly the most effective instrument in exacting obedience from our own species. Here we get a hint of the cause of that want of dignity, that element of coarseness, which is discernible in the countenances of some men and women who have much to do with horses. The higher and nobler method of expressing authority is outweighed by the lower and more animal one.

Generally speaking, it is a strenuous contest with minor difficulties which produces a thin and rigid set of lips. It is seen almost invariably in housewives of the Martha type, who are "careful and troubled about many things," and whose souls are shaken to the center by petty worries within doors, and strife *à outrance* with shortcomings of the scullery maid or the cook.

The compressed lip so loved (and so often misinterpreted) by novelists is a sign of weakness rather than strength. It tells of perpetual conflicts in which the reserves are called into the fray. The strong will is not agitated into strenuous action by the small worries of the hour, and the great occasions which call for its whole forces are too few to produce a permanent impress of this kind upon the features. The commanding officer, assured of his men's obedience, does not habitually keep his lip muscles in a state of tension. Look at the sea captain, the most absolute monarch on earth. He carries authority and power in his face, but it resides in his eye and the confident assurance of his easily set mouth. Every spar and shaft and muscle in his floating realm must obey him, and he knows it. This is probably a reason why the sea captain's and the engine driver's show a certain similarity of type. The engine driver can make his captive giant, strong as ten thousand men, obey the pressure of his finger. His lips are usually calm, like those of the statues of the wielder of thunder-

bolts on Olympus. Who ever saw a man commanding a man-of-war or driving a locomotive with the contentious lip of a school usher?

The typical expressions of the members of those three liberal professions which Sir Thomas Browne says are all founded upon the Fall of Adam are well enough recognized to have been long the prey of the caricaturist. The several distinctive traits of each, and the possible causes which give rise to them, are too complex to be dealt within a single article. Speaking very generally, the cleric's face is indicative of authority (of the thin-lipped kind) and of a dignified sense of the sanctity of his office. The doctor's jaw and mouth are less rigid, yet tell of decision. His eye is vigilant and sympathetic, and his whole facial aspect conveys the idea of a fund of untapped wisdom. The lawyer's countenance is confident and confidential, with a pouncing alertness of the eye, and a prevailing expression of weighty perspicacity.

Of course it must be understood that in such a summary one is dealing with the broadest generalities. Marked exceptions to the rule for each class will be within every one's experience. I am inclined to think that in the learned professions the facial characteristics are much less marked than formerly. This may partly be accounted for by the modern laxity of fashion as to shaving the lip and chin. But also, there can be little doubt that the custom of carrying a sort of perpetual personal trade-mark is diminishing. Military officers no longer wear their uniform in private life, and the doctor and lawyer have both acquired a weakness to be classed, socially, as human beings.

It is noteworthy (and here my own observation has been supported by one of the most alert minds of this generation) that the leading members of the medical and legal professions do not display the facial symbols to anything like the same extent as the rank and file. This is especially so with regard to the expression of the mouth, and may be due to the absence of that anxious endeavor to look like a wise doctor or lawyer which possesses most ordinary practitioners in their earlier years.

The fact that two people who live long together tend to grow alike is accounted for by unconscious mimicry reacting upon the muscles of expression in the same way that a ruling passion does. This tendency to facial imitation is very general—in fact, almost universal—and may be so marked as to be easily noticed; so that when two people are engaged in animated conversation, the expression of the listener may often be seen to echo that of the speaker. How "infectious" is a smile or a laugh, even when the idea which gave rise to it in the first case is not transferred!

Several times, when talking to young people, I have suddenly and purposely adopted some change of expression, such as the

raising of the eyebrows; and this, although not the least apropos to the words spoken at the time, has instantly evoked a like movement on the faces before me. The response was quite involuntary, and was a pure piece of instinctive reflex action. Why does a yawn spread like pestilence through the room when conversation flags? I know of those who have started such an epidemic by a little piece of acting, and not a mouth in the company (save the guilty one) knew why it gaped. Have not we all noticed that a man of marked individuality becomes a center of physical influence to those who wait on his words, so that his gestures, tones of voice, and turns of phrase are reproduced? I know a tutor whose peculiarities of speech and carriage have been adopted more or less by every one of his pupils during the last six years, and several of them have come to resemble him in feature. This unconscious imitation of expression is very noticeable in children. Has it occurred to many careful parents that the good looks of their daughters may depend in no slight degree upon their choice of nurse girls and governesses?

For some reason which we can not fathom, the imitative faculty is so ingrained in us that what the eye perceives the brain makes haste to reproduce without stopping to ask our permission; and where two people live long together the facial muscles of each are constantly receiving stimuli prompting them to mimicry. As in the case of the emotions, these influences may be infinitesimal at any given moment, and may give rise to no visible change of expression. Yet in the course of time they tend to mold the whole countenance, feature for feature, into an almost exact facsimile of another.—*Blackwood's Magazine.*

THE most remarkable feature noticed by Prof. Krasnov, of Kharkov, in his study of the distribution of plants in the island of Sakhalin, is the existence side by side of distinct types of vegetation, due to variations, not of climate, but of soil and relief. This, it is suggested, should be a warning against hasty conclusions as to the succession in past times of distinct types of vegetation in Europe, since it appears possible that they likewise existed side by side. In Java, which he also visited, the similarity of the flora on the tops of the volcanoes with that of the polar swamps suggested to Prof. Krasnov problems as to the evolution of polar forms from tropical prototypes.

A CASE in the Buddhist department of the Gallery of Religions at the British Museum contains an apparatus for exorcising evil spirits which is used by some of the Buddhist sects in Japan. It consists of a brazier surrounded by a small tray for offerings, and bouquets of artificial flowers, the whole encircled by a rope supported on poles. Before this lighted brazier the officiating priest takes his seat, and, reciting appropriate prayers or incantations, burns one by one a bundle of one hundred and eight sticks. Each stick represents one of the wicked spirits "that lead the heart of man into sin," and the exorcism of the whole batch may be assumed to secure a certain immunity from attacks for some time.

SAVAGERY AND SURVIVALS.

By J. WILLIAM BLACK, Ph. D.,
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MR. EDWARD A. FREEMAN, the eminent English historian, has given us a short and popular definition of history in the phrase, "History is past politics." While it is true that history includes past politics, and that the political events of to-day become the history of to-morrow, we must acknowledge that the province of history is more extensive than is indicated in this pithy phrase if we are ready to admit, as it seems we should, that the highest end of history is ethical and social, and not merely political.

We can not say that history is limited for its materials to written records; nor do we agree with Morrison,* who says that history is simply literature, and begins with the historical books of the Old Testament.

We really commence our study of history with the first traces of man's presence upon this earth. His bones are to us not only of physiological but of historical importance. His tools, implements, ornaments, and relics are historical records.

Formerly history was altogether written on the artistic plan. We find that many of the most prominent Greek and Roman writers continually sacrificed the truth to literary finish. Since the middle of this century our conception of history has greatly changed. We regard history as a science, and employ scientific methods in our treatment of historical data. Herodotus's conception of history comes to us again in a new light—"ἱστορία," meaning a learning by investigation.

The study of history conveys to us a knowledge of the intimate connection existing between the past and the present. Much of our material for historical investigation we find not in the past, but in living and present things. Archæology will demonstrate this to us. Thanks to the recent discoveries and excavations of the archæologists of the Capitoline Hill, the history of Rome has been entirely rewritten since the French Revolution. How much new light the study of institutions in the primitive times and among the peoples of to-day, whose development has not kept pace with our own, throws upon the origin of the state and of many of our own social institutions!

History brings to us a knowledge of the past to aid us in the settlement of present problems; and so Droysen's ideal comes to us as the highest and best conception of history. "History," he

* Encyclopædia Britannica, article History, by J. C. Morrison.

says, "is the self-knowledge of humanity; it is the potential knowledge of the present with reference to its development from the past." * Thus, history is not politics, not simply the science of government, and a story of revolutions and conquest, nor simply literature; but is more. It is something which includes the history of culture, of law and custom, the development of the family, justice, the social life as well as the political life. It is an unfolding panorama of the self-conscious development of humanity.

History has become more and more sociological in its character, and perhaps this has caused much of the confusion which surrounds the definition of the comparatively new term "sociology." Auguste Comte and Herbert Spencer have shown a disposition to appropriate this scientific conception of history and call it "sociology," giving history a subordinate place under the latter. What the true position of sociology will be in the hierarchy of sciences time alone can settle. Perhaps we shall ultimately call history in the scientific sense "sociology," putting it, as Comte and Spencer do, at the head of all the sciences, or perhaps we may make of it a philosophy of society, dealing with universal laws and universal types, for which history, its chief adjunct, will furnish the data; or we may regard sociology in a way similar to the popular conception of it at present, as the science which deals with social problems.

It is, however, institutional history or historical sociology that is so attracting the attention of scholars at the present time. There is no study, perhaps, so attractive as the study of primitive society, the habits and customs of savage life, the development of culture and of moral and religious ideas; while its chief profit lies in the solution and understanding of our own progress and development in a continuous line from the historic past. If we would understand the development of our modern state, we must study the beginnings of family life and government, the evolution of the state from the family. To deal intelligently with the divorce problem in modern society, one must study the origin and early history of marriage, and approach the solution of the problem from the historical point of view.

In many of our ceremonial institutions, our fashions, habits, dress, ornamentation, opinions, notions of marriage, property, and law we are but the slaves of the customs and traditions of the past. It may be of interest to look at some of these habits and customs of savage life. We might ask the question, "How is the course of civilization traced?" One means is through the aid of survivals. And what do we mean by "survivals?" "Those

* Droysen's Principles of History.

opinions, customs, and peculiar notions of ours which require an explanation for their presence and which represent an older period of culture."* The Hindu, for example, continues to use the primitive fire-drill for kindling the sacred fires, although the lucifer match is used for all other purposes. Catlin noticed a similar custom among many Indian tribes of North America. The ancient Eygptians continued the use of the stone knife in the religious rite of circumcision long after the introduction of the metals. The institution of marriage to-day offers us illustrations of ceremonies which seem a necessary part of the institution; and yet, if we were asked for rational explanations of them, we should be at a loss to explain, were we not able to appeal to the evidence of history and call them survivals.

How can we explain the wedding cake, the bridal tour, the storm of rice and old shoes accompanying the departure of the happy couple, without an appeal to the customs of the past? The coyness of the maiden to-day is fully equaled by that of the savage maiden. It is customary with the latter to manifest opposition to entering the paths of matrimony, though that opposition in some cases is merely feigned. This probably originated—as most writers agree—among nations who were in the habit of capturing their wives from hostile tribes, but it has lingered as a conventional observance in cases where the change of state is not distasteful. Marriage by capture is not uncommon, and prevails among some of the Hindu tribes, Circassians, and the primitive races of Australia, New Zealand, and America; and survivals of this custom to-day would seem to indicate traces of this institution among the early Aryan and Semitic races. The rape of the Sabines affords a good illustration of this custom among the early Romans.

The primitive form of marriage by capture, however, gave way later to the ceremony of marriage by purchase, a price being paid by the groom to the parents of his bride, and the marriage contract being settled generally without the latter's consent. In this second stage, where the bride was secured by a more peaceful method, the violence accompanying the former mode of securing a wife still lingered in the form of a survival. In turn, the custom of purchasing a bride passed from the stage of reality to the ceremonial stage. Among the New-Zealanders a bride is only secured after a prolonged struggle between the friends of the groom and the friends of the bride. Among certain tribes of India the groom is obliged to overcome a strong man who is appointed to defend the bride. A curious parallel to this is noted among the Eskimos. The youthful candidate to matrimony is

* Tylor's Primitive Culture, vol. i, chap. iii.

only qualified to marry after he has succeeded in killing a polar bear without assistance. This is taken as an evidence of his ability to provide for the wants of the household. In Turkey a prominent part of the ceremony is the chasing of the bridegroom by the guests, who strike him and hurl their slippers at him. And what adds zest to the occasion is the fact that these onslaughts are usually led by the females who were disappointed at the loss of a former lover. Another survival of marriage by capture is discovered among the Ceylonese, where it is common at royal marriages for the king and queen to throw perfumed balls and squirt scented water at each other.

As stated above, even in the latter stage of marriage by purchase, where the marriage contract is settled on a friendly basis, the symbol of capture is still maintained. For example, after the purchase price is agreed upon, the girl is given the privilege of running for her independence. This is known as "bride-racing," and takes various forms. In one instance, the girl is mounted on a swift horse; she is given a good start, and then pursued by her lover similarly mounted. If he overtakes her, she becomes his bride. If not, the marriage is declared off. As a rule, however, after a little exciting sport, the girl allows herself to be overtaken.

Among other tribes, we find the symbol of capture perpetuated in the foot race, or water chase in canoes; or the race may be run through a series of tents, as observed by Mr. Kennan in Siberia. In this case all sorts of obstructions are placed in the way of the groom by the friends of the bride, and if he be successful in running the gantlet and jumping the improvised hurdles in time to catch the girl he becomes a Benedict. It is also a custom for the "fair one," if she be more fleet-footed than her lover, to wait kindly in the last tent until he joins her.

Thus it is general among uncivilized peoples to accompany the wedding ceremony with violence of some sort. Kicking and screaming on the part of the bride are considered an evidence of modesty; and the stouter her resistance and the more violent her convulsions, the greater is she appreciated ever after by her husband and her own friends. It is said even to-day that the young girl hardest to woo is best appreciated by her lover.

Marriage among the Greeks and Romans consisted of three acts: First, the quitting of the paternal hearth; second, the conducting of the young girl to the house of her husband, accompanied by relatives and friends and preceded by the nuptial torch. Then the act of violence survives in the following, the third part of the ceremony; for at this point it was the duty of the groom to seize the bride and carry her into his house without allowing her feet to touch the sill. Around the domestic hearth the hus-

band and wife now gather, offer sacrifices, say prayers, and eat of the sacred wheaten cake. This last performance, which still survives in our wedding-cake of to-day, was of great importance, as it cemented and sanctified the union of the two, who were now associated together in the same domestic circle and the same worship.

The wedding feast is of ancient origin, and probably originated, as Westermarck points out, in the purchase stage, where the feast was regarded as a part of the purchase price paid by the groom; or, in cases where the expenses were met by the parents of the bride, as part compensation for the sum of money paid for the bride. The custom of giving presents to the bride is also interesting in its origin. In all probability it also came from the purchase sum paid by the groom to the family of his bride, this purchase sum degenerating into a mere present, more or less arbitrary, which in some cases was returned to the giver; in others, given to the bride. In Athens, during an early period, the dower was known, for the bride was frequently provided with a marriage portion by her father or guardian. This led to the giving of presents by the bridegroom to his wife. It was a common observance for gifts to be exchanged between the bride and groom or their guardians, and numerous instances of this are recorded. It is a part of the ceremony in China and Japan; and Tacitus relates a similar custom among the Germans. Thus the custom of giving the bride a good start in life with the aid of presents is not new; while the bridal tour, and the practice of throwing rice and old shoes after the departing bride and groom, are symbols of the violence that formerly accompanied the marriage ceremony. Even more dangerous weapons were used within recent times, for it is related to have been a custom among the Irish to cast darts at the bridal party. On one occasion, however, a certain Lord Hoath lost an eye by the foolish practice, and since that time it has become obsolete, less harmful weapons having been substituted. The "best man" of to-day was formerly the chief lieutenant of the groom in the act of capturing his bride, while we find the wedding ring in use among the ancient Hindus. Among the Ceylonese the latter takes a curious form, for "the bride ties a thin cord of her own twisting round the bridegroom's waist, and they are then husband and wife."* This he wears through life as an emblem of the union. The ceremony would indicate that among these people the woman is "the boss." This, however, is contrary to the usual custom which we find among many other tribes, for the boxing of the bride's ears by her husband to indicate that he is master is an important part

* Westermarck's The History of Human Marriage, p. 420.

of some ceremonies, while it is said that in ancient Russia the father, taking a new whip, would strike his daughter gently, and then hand it over to the groom, indicating thereby that a change of master had taken place.

The blood-feud or revenge offers a field of similar interest to a student of legal and institutional history. Formerly, before the age of judges, state prisons, and reformatory institutions, it was the custom for an individual to take the law into his own hands. "Self-help," says Farrer, "is for individuals the first rule of existence. But generally this deficiency in the legal protection of life and property is made up for by a principle which lies at the root of savage law—the principle, that is, of collective responsibility, of including in the guilt of an individual all his blood relations jointly or singly." * One can see upon reflection why the avenging of murders or wrongs committed should be regarded as a family or tribal rather than a personal affair, on account of the powerful influence it must have in repelling crime and keeping the public peace. A good illustration of blood vengeance we have among the native Australians to-day, where it is regarded as one's holiest duty to avenge the death of his nearest relation. The force of public opinion compels the man to do his duty by his relative. It is the custom among a certain Brazilian tribe for the "murderer of a fellow-tribesman to be conducted by his relatives to those of the deceased, to be by them forthwith strangled and buried, in satisfaction of their rights; the two families eating together for several days after the event as though for the purpose of reconciliation." But the affair is not always so happily and permanently healed, for if the guilty one escape the avenger slays his nearest relative. Consequently, it was a matter of the greatest importance that the punishment should be visited upon the real culprit, and frequently both families united in hunting down the murderer. But more often, where the innocent received the punishment due the guilty, hereditary feuds sprang up between the tribes, and tribal warfare resulted.

The right of revenge was a recognized principle of the Jewish law, as seen in the following quotation from Exodus: "And if any mischief follow, then thou shalt give life for life, eye for eye, tooth for tooth, hand for hand, foot for foot, burning for burning, wound for wound, stripe for stripe." † It was likewise a right recognized by the law and custom of the Germans. In time the right of revenge gave way and certain modifications of the old institution were made to relieve its severity. This was probably due, as Tylor suggests, to the increase of population and the growth of town life. Among the Jews the right of revenge was suspended on

* Farrer's Primitive Manners and Customs, p. 163. † Exodus, xxi, 23–25.

certain festival days, and cities of refuge were established, whither the criminal might flee and be safe; or, as in Western Australia, "crimes might be compounded by the criminal committing himself to the ordeal of having spears thrown at him by all such persons as conceive themselves to have been aggrieved," care being taken, however, to limit the punishment in such a way that the prisoner might escape without mortal wounds. But the law in the interest of peace and progress soon fixed upon a composition for the crime, known as "*wergild*, or man-money." Such was the practice of our Anglo-Saxon forefathers less than a thousand years ago, when the *wergild*, or fine, of which our judicial fines are a survival, was regarded a fitting substitute for personal vengeance. The survival of the law of retaliation, as expressed in the passage from Exodus, is seen in the composition provided for each part of the body. The teeth, hair, nails, and other parts had their peculiar value, the hair being especially prized. For instance, the loss of the beard was estimated at twenty shillings, while a broken thigh was worth only twelve. The loss of a front tooth was reckoned at six shillings and a fractured rib at three. The composition for a freeman was two hundred shillings, or half price for the loss of a foot or hand, five shillings for the little-finger nail, and so on. There is one point, however, that deserves notice in this connection. The value of a man varied according to his rank, the royal *thegn* or lord being rated as high as twelve hundred shillings. While impartiality with regard to rank or wealth is the rule of justice in all civilized communities to-day, yet in many instances it seems as difficult for our courts and juries to overlook these factors as it was in Anglo-Saxon law, and the big embezzler stands an infinitely greater chance of escaping punishment befitting the crime than the petty thief.

Our criminal law grew out of the old private vengeance, but in accordance with modern ideas the state, representing the community, has become the avenger. While the older method of family responsibility went a long way toward securing orderly government, it has given way to the better plan of holding the individual responsible, though the traces of the former still linger on in the ignominy which seems even in these days to attach to the relatives of a criminal.

When we speak of the vengeance of the law, the old idea that the law is being avenged by the punishment of the criminal is revived; but the prevailing idea in dealing with the criminal classes is that punishment is exacted for the benefit of society and for the repression of crime. The public prosecutor stands in the place of the avenger, and witnesses may be compelled by the state to appear in the interest of the public peace. The blood-

feud, or vendetta, still lingers as a survival almost in our very midst, in the mountain regions of our South. It is not an uncommon thing to read in our papers of the perpetration of some atrocious crime as the result of a long-standing feud between the Hatfields and the McCoys, the Frenchs and Eversoles, or the Jarvises and the Kendalls. And it is surprising that often when the law once gets its grip upon these modern savages it does not repress them by a wholesome administration of justice. As a matter of fact, it is difficult to secure a conviction or anything more than a very light sentence for a willful aggressor in our Southern vendetta.

The international prize fight is a degenerate suggestion of the old tribal champion, who was appointed to defend his country in single combat against the representative of a hostile nation. Of this primitive institution, the familiar stories of David and Goliath, and the Horatii and the Curatii, are good illustrations. Passing now to a different branch of our subject, let us glance at a few peculiarities of savage life with regard to dress, ornamentation, and bodily disfigurements. On these subjects Prof. Frederick Starr's recent articles* in The Popular Science Monthly will be found full of interesting and suggestive facts.

It is a matter of uncertainty how dress has developed until it has reached its present form among civilized peoples. While it is probable that the desire for ornamentation, which is usually the first thought in the savage mind, led to its adoption and development, protection and modesty also contributed; for, as Tylor says, it was a custom among the Andaman-Islanders to plaster themselves with a mixture of lard and clay as a shield against the heat and mosquitoes. Among the rudest races, and even in the warm climates, we find clothing worn, or, as a fitting substitute the body is painted, tattooed, or plastered, as described.

It was an early custom to wear a girdle about the waist, and from this suspend skins, feathers, and other ornaments. In time this led to the wearing of a loose robe for the covering of the body, which is known as the southern type of dress, so common in the Orient, notably in China, Japan, as well as in ancient Egypt, Greece, and Rome; while in the north, where the climate demanded the greater protection of the body, the close-fitting garment, including jacket and trousers, at first made of skins, became the prevailing costume. The Eskimos, for instance, have long worn this type of dress. Skins and furs made the most durable garments, and as a covering for our feet we have yet to find something to supplant this inheritance of savage times. In the

* Popular Science Monthly, August, October, November, December, 1891. Articles on Dress and Adornment.

absence of skins, the leaves of the forest were used for costuming, and one is often reminded of this savage custom in the diversions of the rural picnic party, when the leaves of the forest are woven into primitive garlands and aprons. In Brazilian forests Nature is especially kind to the savage, for upon the "shirt tree" is grown the ready-made garment. All the native has to do is to remove the bark of the tree, cut slits in it for armholes, soak and soften the bark, and then place it upon his body. The plaiting of mats for clothing, followed by the invention of the loom, and the weaving of cloth are interesting processes connected with the development of dress.

In contrasting the close-fitting garment of the northern type with the loose-fitting or blanket type of garment in the South, Prof. Starr is led to make the suggestion that this accounts for the two prevailing types of dress which exist in civilized society to-day. One of the great conservative elements in society is woman, who stands as a useful brake upon rash and too impetuous change. "The northern and southern types of dress once came in conflict. The time was that of the invasions of the northern barbarians upon imperial Rome. Both men and women, in the ancient days of Rome, wore the southern dress. The barbarians wore the tighter-fitting garments of their colder climate. The southern man adopted the more convenient type, the woman did not; and so we see to-day our men in jackets with tight sleeves and close-fitting trousers, while women continue to wear in a modified form the dress of the sunny South—flowing garments, skirts and cloaks." *

We are reminded of this southern type of dress in the spotless robes and vestments of the priest and chorister; and it is not difficult to see in the cap-and-gown fad, which has recently attacked our colleges with the vigor of a prairie fire, a survival of this classic type of dress.

A curious costume is that of the medicine man, the most unique and important individual among savage races. His object is to terrorize his patient by his grotesque costume, his weird movements and incantations, and to kill or cure as the case may be. Catlin gives a picture of one and describes his movements. His body and head were covered with the skin of a yellow bear, the head serving as a mask, a rare and conspicuous thing to begin with. "The huge claws dangled upon his wrists and ankles. In his right hand he shook a frightful rattle, in the other he brandished his medicine spear or magic wand." † The medicine man ordinarily administers to his patient roots and herbs, and if these

* Popular Science Monthly, October, 1891, p. 800.

† Smithsonian Report, 1885, Part II, pp. 417–419.

fail, then as a last rite he arrays himself in his strange dress and goes through his hocus-pocus over the dying man, with the expectation that his mysterious and magical skill may be invoked at this point to save the patient. In case of an adverse result, however, he easily maintains his self-respect in the community by the explanation that "it was the will of the Good Spirit." An illustration of savage logic is also interesting in this connection, for the medicine man argues by analogy that extraordinary cases demand extraordinary remedies. Dorman relates an incident which seems to substantiate this. "An Indian warrior was brought to camp after a most disastrous encounter with a grizzly bear. The doctor compounded a medicine that ought really to have worked wonders. It was made by boiling together a collection of miscellaneous weeds, a handful of chewing tobacco, the heads of four rattlesnakes, and a select assortment of worn-out moccasins. The decoction thus obtained was seasoned with a little crude petroleum and a larger quantity of red pepper, and the patient was directed to take a pint of the mixture every half hour. He was a brave man, conspicuous for his fortitude under suffering, but after taking his first dose he turned over and died with the utmost expedition."

Savages are very fond of ornaments, and in some respects we resemble them—with this difference, that in savage life it is the men who are the most highly decorated. The incentive of personal adornment was, as it is now, due to the desire to make one's self prominent or conspicuous in the eyes of others. As proud as the schoolboy is of his medal received as a reward of merit, so is the savage of his trophies, which he wears as a mark of his prowess in battle, or in an encounter with some wild beast. Necklaces, bracelets, and earrings made of these trophies were among the earliest ornaments worn. Teeth, claws, shells, pearls, ivory, bone, hair, and feathers were commonly used, while the brass plates for keyholes, sardine boxes, and other metallic objects are said to be especially prized. On the arms circular rings of ivory, iron, or copper were worn, and the savage delights to load himself to the extent of physical endurance with these heavy and useless appendages. Schweinfurth, the African explorer, thus describes the ornaments of the Dinka, a Central African tribe: "The wives of some of the wealthy are often laden with iron to such a degree that, without exaggeration, I may affirm that I have seen several carrying about with them close upon half a hundred weight of these savage ornaments. The heavy rings with which the women load their wrists and ankles clank and resound like the fetters of slaves. . . . The favorite ornaments of the men are massive ivory rings, which they wear round the upper part of the arm; the rich adorn themselves from elbows to wrists with a whole series of rings,

close together so as to touch."* It is said that an African princess, who had her arm covered from wrist to shoulder with these curious bracelets, suffered so much from the heat of the sun playing upon these rings, that she was obliged to hire a maid, whose duty it was to attend her constantly and cool them from a watering pot.

Thus the different parts of the body—the neck, arms, and ankles—which Nature has so abundantly provided for the carrying of ornaments are utilized; and, what is still more curious, the savage, not satisfied with this, cuts holes in himself for the purpose of carrying others. The most frequent mutilations are those of the lip, cheek, nose, and ear. Some curious illustrations of this custom are related by Schweinfurth. The upper lip is pierced, and there is inserted a round-headed copper nail or a copper plate. Among the Bongos, the women suffer a hideous mutilation for the purpose of extending the lower lip. A hole is bored in it, and in this a wooden plug is fitted, which is gradually enlarged until the lip is five or six times its original size. In this way, by wearing these plugs, which are an inch in thickness, the lower lip remains extended beyond the upper, though the latter is similarly pierced and fitted with a smaller copper plate or nail or bit of straw. The lips are similarly extended sometimes by the insertion of circular plates of quartz, ivory, or horn the size of a half-dollar. These cause the lips to rest in a horizontal position, and when the wearer is in a fit of anger have their advantages, for these cymbal-like attachments on the lips add noise and effect to the chattering of the individual. It is likely that the wooden or quartz plug which is so often inserted in the lower lip was suggested by the horn of the rhinoceros. Not content with labial adornment, they attack the nose in the same manner, small bits of straw being fitted into each side of the nostrils. Occasionally the cartilage between the nostrils is pierced, and a wooden plug or copper ring is worn. This is a common sight among Indian tribes. The ear is often pierced in many places, sufficient to carry a half dozen rings. The slitting and the stretching of the ear is also a common practice. Mr. Catlin gives a picture of a chief in a Delaware tribe, "Lay-law-she-kaw"—i. e, "He who goes up the river"—who had his ears slit and elongated to the shoulders, through the wearing of heavy weights in them at times. When on parade, he made use of them as quivers, carrying in that way a bunch of quills or arrows for the sake of ornament. Other savages use them for the carrying of snuffboxes or knives; and I have known a Chinaman in these days to make use of his ear as a pocketbook, in which he carried

* Schweinfurth's The Heart of Africa, vol. i, p. 153.

his car fare until called for by the conductor. Just as the dress or bodily ornaments characterize the tribe, so does the peculiar style of disfigurement serve as a tribal mark as well as a decoration. Some file the teeth in fantastic shapes; others bore and stud them with brass nails. Among some African tribes it is the custom to break off the lower jaw teeth. Sometimes they are filed to a point for the purpose of griping the arm of an adversary in wrestling or in single combat.

In tribal or family distinctions they do not stop here, for body-painting, tattooing, gashing the face and body were used for the purpose, while the savage can give the moderns many valuable points on dressing the hair. "The ancient Egyptian woman had blue hair, green eyelashes, painted teeth, and reddened cheeks, while the modern Egyptian follows similar fashions, prolonging the eyes by means of a drug, staining the nails brown, and painting blue stars on the chin and forehead." One does not have to go far in our own land to find a physiognomy as artificial in its makeup as that of the savage or Egyptian; while the painted face of the savage and the Indian is still kept before us in a more grotesque and ludicrous form in the curiously painted face of the circus clown.

Tattooing is a mode of ornamentation adopted by a great number of savage tribes, but with the development of dress, skin decorations cease, and as we get higher up in civilization but few remains of these savage customs are found. Our sailors, however, have shown a considerable degree of conservatism in preserving this custom.

Gashing is one of the most curious of all practices. "In South Africa, the Nyambanas," says Lubbock, "are characterized by a row of pimples or warts, about the size of a pea, and extending from the upper part of the forehead to the top of the the nose. . . . The tribal mark of the Bunns (Africa) consists of three slashes from the crown of the head down the face toward the mouth; the ridges of flesh stand out in bold relief. This painful operation is performed by cutting the skin and taking out a strip of flesh; palm oil and wood ashes are then rubbed into the wound, thus causing a thick ridge upon healing. . . . The Eskimos from Mackenzie River make two openings in their cheeks, one on each side, which they gradually enlarge, and in which they wear an ornament of straw resembling in form a large stud, and which may therefore be called a cheek stud." *

I am told that now some young women occasionally submit to a rather painful surgical operation for the removal of a piece of

* Lubbock's Origin of Civilization, chap. ii, p. 59.

flesh from the chin or cheek, the result being, upon the healing of the wound, the appearance of a coquettish dimple.

With the progress of civilization, the tendency is to dispense to a greater or less degree with the various forms of bodily ornamentation, and the most painful operations for the adornment of the person are given up first. The piercing of the ear, however, is still common, and continues to remind us of the customs of savages, but perhaps the day is not far distant when the earring, the bracelet, the superabundant finger-ring, the costly diamond necklace, and other reminders of savage life and social inequality may give way before the spirit of democracy which is coming to prevail more and more in our social as well as political life. And yet we must not underrate the importance that these facts from savage life have played in the world's progress. The dude, as Prof. Starr reminds us, occupies an important place in the history of culture, for personal vanity and the desire to emphasize one's individuality have done much toward the development of our æsthetic senses, and as well for the arts and sciences, and for the cultivation and satisfaction of wants outside of the mere primitive needs of food and clothing.

One might go on multiplying by the hundreds illustrations of the peculiarities of savage life, and suggesting interesting and curious survivals, but the scope of a single short article would not permit the mention of a great variety of topics that properly come within the field of primitive institutions and survivals. Volumes of interesting facts have already been gathered upon this vast and comparatively new department of study, and any one who enters upon it will increase his respect for the advantages which modern civilization has brought to us. If we examine, from the historical point of view, language, customs, mythology, mathematics, jurisprudence, property, folklore, morals, religious beliefs and superstitions, we shall find "savage opinion in a more or less rudimentary state, of which civilized man still bears the traces, and over which state he represents the greatest advance." We hear of the "freedom of the savage," but we need to remember that he is utterly dependent upon Nature for his support and is a slave to his own passions. It is estimated that it requires fifty thousand acres, or seventy-eight square miles, for the support of one man in the primitive hunting and fishing stage; consequently, as their numbers increase they are driven to cannibalism in self-defense. But with the progress of civilization, man increases his dominion over Nature, and, as a rule, we find the most highly civilized countries those where the population is densest and production greatest. Our great World's Fair presented us with a magnificent object lesson of man's power over Nature. The marvelous rapidity of

our progress within recent years, the numerous discoveries and inventions for shortening time and space, increasing production, combating disease, etc., seem almost to indicate that we are scarcely more than upon the very threshold of civilization. To quote a short sentence from Tylor, "The unconscious evolution of society is giving place to its conscious development, and the reformer's path of the future must be laid out on deliberate calculation from the track of the past."* If this be our understanding of scientific history, then we accept the conception of history with which we started—that is, we agree that "history is the self-conscious development of society."

SKETCH OF HEINRICH HERTZ.

By HELENE BONFORT.

WHEREVER the investigating minds of scientists are at work promoting the insight of man into the mysteries of Nature, wherever friends of natural philosophy are keenly alive to the importance of this comparatively new field of study, a field in which lie some of the most essential interests of modern civilization, there will be sincere and deep regret over the death of a young professor whose splendid career came to an untimely end on the first day of this year. Prof. Heinrich Hertz, of the University of Bonn, in Germany, died on January 1, 1894, not yet thirty-seven years of age. For the last two years he had not been in good health, and, though under the treatment of his capable physicians he several times rallied and seemed to be restored to his former strength, the last winter brought a serious relapse. A chronic and painful disease of the nose spread to the neighboring Highmore's cavity and gradually led to blood-poisoning. He was conscious and in possession of his full mental power to the last; he must have been aware that recovery was hopeless, but not a word escaped his lips that would have shown to his dear ones whether hope or fear filled his heart. His wife and his mother were at his bedside for many weeks, giving him their tenderest care, and, in spite of his continuous sufferings, there were many hours of genial discourse. At such times they read to him, and he gave himself up to general topics and to matters of personal interest to them, displaying even yet his wonted brightness and cheerfulness.

HEINRICH HERTZ, born in Hamburg on February 22, 1857, was the eldest son of exceptionally good and clever parents. His

* Contemporary Review (article on Primitive Society), vol. xxii, p. 72.

father was, at the beginning of his career, a lawyer; in due course of time he rose to the position of judge of the Supreme Court of Appeal, and has now been for a number of years a senator of the free city of Hamburg. The childhood of Prof. Hertz was subject to every pure, healthful, and elevating influence that a highly capable father and a superior mother can exercise. Both of them gave a great part of their time to their children; their eldest boy especially enjoyed the advantage of their companionship in many a holiday's ramble through the green fields and woods, and in cozy winter nights spent in reading Homer, the German classics, and other books.

In passing through the high-school classes of his native city, his predilection for the study of natural science early asserted itself. Whenever a new course of study began and a new text-book was put into the hands of the class, the boy would devote every leisure moment to the perusal of the volume, experimenting frequently with apparatus made by himself, and never ceasing until he could tell his father, "I have mastered that book." This statement always proved to be perfectly correct. In spite of his decided gift for natural science, Hertz chose as his vocation civil engineering. But when, after completing his studies, he came to take the first steps toward the practical execution of this design, he felt that his choice had been a mistake. His parents, with a ready perception of the deeply rooted needs of his strong and peculiar nature, whose desires they would not think of thwarting, entered into his new idea, gave him their approval, and furnished him with the necessary means. So he set out on a new course of studies in mathematics and natural science. He gave himself up to this work heart and soul, and for a number of years knew no other object in life but unceasing and unrelenting hard work. He studied physics at Munich and Berlin, and enjoyed the warm regard of Prof. Helmholtz. In 1880 he became his assistant, and, at his instigation, in 1883 settled down as a "Privatdocent," or professor without salary at the University of Kiel. It was from this time on that he made the science of electricity the one great object of his researches, the main pursuit of his life. The first years were filled with investigations relating to electric discharges, etc. He busied himself, above all, with the new conceptions of the inner mechanism of electric phenomena, and of the connection between these and the phenomena of light and of radiant heat. These conceptions, originating with Faraday and Maxwell in England and represented in Germany by Helmholtz, were now carried forward by Prof. Hertz.

His reputation soon spread through his native country and he was in 1885 called to the Polytechnic School of Karlsruhe, which for various reasons became very dear to him. One of its attrac-

tions was the exceptionally fine and well-endowed laboratory of the institution, which furnished the most desirable facilities for unlimited experimenting. At Karlsruhe Prof. Hertz found a wife who was in every way a lovely and graceful, devoted and highly intellectual companion to him. His life was from this time on divided between the pursuit of his main object, the progress of science, and home happiness; both he and his wife derived rare gratification from literature and the beauty of Nature. It was from Karlsruhe that he went to Heidelberg, there to enjoy the proudest moment of his life, in the year 1889, when, greeted with enthusiastic applause by most prominent scientists, he stood up on the platform to tender an account of his researches and their results. Who that saw him there, the very picture of youthful vigor and life, could have foreboded that those fine and penetrating eyes, to which for the first time since our earth turned around its poles electric waves had been revealed, were so soon to be closed in death!

Soon Prof. Hertz received flattering calls to the most prominent universities; he preferred the smaller town of Bonn, where he settled down in 1890, even to Berlin, the capital, because what he sought after was the most serious and fruitful work, not glory and outward advantage. In Bonn he succeeded to the eminent physicist, Prof. Clausius; this was in itself a high distinction conferred upon so young a man as Prof. Hertz. Considered all over Europe as one of the most prominent, he was looked up to as one of the most promising leaders in the science of electricity. Not only had his own country conferred high honors upon this young and ardent worker, but the chief academies of England, France, Italy, Austria, and Russia now crowned his efforts with prizes, honorary memberships, and other tokens of universal esteem and gratitude.

Up to the middle of this century the phenomena of electricity and magnetism had been only inadequately explained by applying to them Newton's law of gravitation and asserting that, in the same way as celestial bodies exercise power of attraction at a distance and without the intervention of a medium, the two kinds of material electricity were attracting and repelling each other, while passing through space or through non-conductors.

It was the great English physicist Faraday who first sought to carry the knowledge of electricity to a higher stage, by entering upon the study of phenomena with a mind free from preconceived opinions. He put forth as the foundation on which to base new theories his observations of electric and magnetic forces, their influence upon each other, their attractions for material bodies, and their propagation by the transmission of the excitation from one point of space to another. He questioned the

assumption of space being void, and conjectured that the ether which transmits the luminous waves suffers modifications perceived under the form of electrical and magnetic manifestations. His discoveries, important as they were, gained due consideration only when Faraday's great countryman, Maxwell, treated the same subject in a purely scientific and theoretical way, publishing in 1865 his Mathematical Theory of Light. The nature and properties of ether he left undecided, and they form to this day dominant questions, destined, it seems, ultimately to reveal the deepest secrets of natural science. Maxwell labored to confirm the connection, surmised by Faraday, between light, electricity, and magnetism; the idea of velocity now entered the theory and became of supreme importance. Maxwell arrived at the conclusion that the velocity of electromotion in a given medium must be identical with the velocity of light in the same medium, and that therefore ether, being contained in all ponderable bodies, would have to be looked upon as the conductor of electric motion and power. Consequently the periodical motions of ether, which our eye conceives as light, and which he figured as transversal waves, were considered by Maxwell to be at the same time undulations of electricity. These conceptions, unproved by experiment as Maxwell left them, had merely the value of a scientific hypothesis emanating from a man of rare genius. To have proved them facts, and thereby to have united two vast and highly important domains of natural philosophy, is the lasting credit of Prof. Hertz.

The complexity of phenomena of light and electricity and the insufficient opportunities afforded by the laboratory for deductions of such magnitude rendered the obstacles barring the road to exact observation well-nigh insurmountable. Many of the best and ablest naturalists were laboring to cope with these difficulties. Two English scientists of highest standing, Prof. G. F. Fitzgerald and Dr. O. T. Lodge, were during the eighties occupied with experiments for the investigation and measurement of electric waves. But it was reserved for Hertz to discover and apply with marvelous ingenuity the necessary "detector," a resonating circuit with an air-gap, the resistance of which is broken down by well-timed impulses, so that visible sparks are produced. After an unceasing course of experiments, in which he manifested indefatigable energy and a wonderful faculty of reaching the very essence of the matter, he succeeded in deciding the questions: Is the propagation of electrical and magnetic forces instantaneous? and further: Can electrical or magnetic effects be obtained directly from light? The paper On very Rapid Electric Oscillations, which was published in 1887, was the first of a splendid series of researches which appeared in Wiedemann's

Annalen between the years 1887 and 1890, and in which Hertz showed with ample experimental proof and illustration that electromagnetic actions are propagated with finite velocity through space. These twelve epoch-making papers were afterward republished—with an introductory chapter of singular interest and value, and a reprint of some observations on electric discharges made by von Bezold in 1870—under the title Untersuchungen über die Ausbreitung der elektrischen Kraft. A translation of this book, entitled Electric Waves, by D. E. Jones, B. Sc., with illustrations and a preface by Lord Kelvin, has just been published in England.

In 1889, when laying before the Congress of German Naturalists at Heidelberg the results of his labors, Prof. Hertz, with the modesty characteristic of the true investigator, the utterly unassuming disciple of science, gave ready and graceful acknowledgment to the efforts made by his predecessors or co-operators in the work, some of whom had all but attained the results which they aimed at and which he achieved. It is pleasant to recollect that when he had gained the end toward which they also had been striving, the English professors, Oliver Lodge and Fitzgerald, were foremost in announcing his success, and in preparing the English-speaking world to appreciate the importance of his discoveries. A natural bent of mind toward the questions at issue had awakened the young professor's creative powers; his complete concentration upon the vital point and his intuitive perceptions led him to definite results and complete success where so many able minds had searched in vain. In the April number of this magazine Herbert Spencer, speaking of the late Prof. Tyndall, gives a number of traits that apply with singular force and exactness to Prof. Hertz. Of these the first is "the scientific use of the imagination." It may well be said that with this constructive imagination, as Mr. Spencer terms it, originated Prof. Hertz's rare success as a discoverer and as an instructor.

To find out the most effective arrangement of electrical conductors and to secure the conditions which would produce the strongest vibrations at regular intervals and in quickest succession, we might say the adjustment of his instruments was the first part of his work. Having brought about electric undulations up to several hundred millions in one second, Hertz proved through experiment that the waves of electricity are transversal like those of light, and that the transmission requires a certain lapse of time. He ascertained exactly the velocity of electricity; it is found by multiplying the length of wave, which he measured, by the duration of the vibration, which can be calculated, and he found this velocity to be, as Maxwell had supposed, equal to that of light, and, moreover, equal to the velocity of electric waves in

metallic wires. The grand consequence of this last discovery was the cognizance of a new fact: that what had hitherto been considered as a current of electricity *in* a wire is really a movement along the surface of the wire. Maxwell's magnetic theory of light found further corroboration by the experimental demonstration of electric power as propagating from its center in waves similar to sound. The electric undulations are subject to the same process of reflection, refraction, absorption, etc., as the rays and waves of light, from which they are in the end distinguished only by their considerably greater length, measured sometimes by kilometres. The crowning experiments of this course finally changed what had hitherto been looked upon as a coincidence between two orders of distinct phenomena into a demonstration of identity. By gathering the electric spark in the focus of a large concave mirror, whence it came forth in the form of a rectilinear beam, the properties of the electric ray were shown to be identical with those of a luminous ray, the former producing phenomena which have heretofore been observed only in light—those of polarization. This result renders all theorizing on the matter superfluous: the identity of the two powers springs from the experiment itself; ocular proof is produced for the proposition that light is in its very essence an electrical phenomenon, whether it be the light of the sun, of a candle, or of a glowworm. Suppress electricity in the universe—light would disappear. Suppress the luminiferous ether—electric and magnetic forces would cease to act through space. Even a body not casting light can be a center of electrical action if it radiates heat. Electricity therefore possesses all Nature and even man. The eye itself is, in fact, an electrical organ.

The influence of this new system of physics upon the development of natural science and the manifold applications in practical life of which it is capable can not easily be overrated. Only recently a new application of Hertz's discovery was made by an American, who is trying to develop photographs by the agency of the Hertzian waves, as science has named them—that is, by electricity instead of light. Hertzian waves, Hertzian investigations, apparatus, and methods form henceforth an essential part of all hand and text books of electricity. The facts established by Hertz's experiments have been molded into a mathematical formula by their author, who in this purely theoretical work also has shown himself to be a master of high genius in the realm of abstract science. There is at present in press and will soon be issued by T. A. Barth, at Leipsic, a comprehensive work, Principles of Mechanics in a New Connection, found among his unpublished papers at the death of Prof. Hertz. Its appearance is eagerly watched for by the scientific world.

However highly his own time and posterity may prize the man of science, the great discoverer, in Prof. Hertz, his value as such to the world at large does not surpass that of the rare purity and greatness of his character, of the intrinsic merit which he possessed for those who knew him personally. A world-wide reputation so rapidly attained might have produced in the young man some feeling of elation and pride, and in his colleagues somewhat of envy. But, as Prof. Hubert Ludwig, representing the University of Bonn at Prof. Hertz's funeral in Hamburg, said in his memorial speech:

"The rich harvest of fame and glory which was granted him, and that was so fully merited as not to be tainted by a single breath of envy or jealousy, never caused him to give up one atom of the noble simplicity and genuine modesty which were a fundamental trait of his character. His modesty was a most lovable quality in this great man, asserting itself not only in every-day life, but also in his scientific labors, which it pervades with the endearing charm of an amiable personality. It was coupled with the most considerate indulgence when judging others. His ever-ready recognition of other people's merits made it a sheer impossibility to grudge him his attainments or to be his enemy.

"'None knew him but to love him,
None named him but to praise.'

At the same time he was governed by an inflexible veracity."

He was indeed a most lovable man, and was never happier than in giving pleasure to others. His kindness and benevolence found expression in many ways, most of all toward those above whom he was placed as head of his department in the university. It was a pleasure to notice his satisfaction, when he found it in accordance with his duty, to confer a benefit or favor. And when it was incumbent upon him to refuse or displease, he became the director who performed his duty, and the friend who regretted what had to be done. He was always ready to show hospitality to scientific men who came to Bonn from other parts of Germany or from foreign countries. Even under the restraint of a foreign tongue (he spoke English and French with considerable fluency) his conversation was charming. Not what he had achieved, gave him his ascendency in scientific discourse, but what he, beyond a thousand learned men, could achieve at any time—original and sagacious thoughts, springing up on the spur of the moment, and losing none of their force by being expressed in the most unpretending, simple form. When entertaining friends or conversing with his dear ones, he perfectly forgot the learned professor in himself; he was so much at his ease, so full of fun, that none around him could help sharing his gayety. Many of his guests,

prominent men of science as well as students, will always remember with pleasure and gratitude delightful trips made with Prof. Hertz to the Siebengebirge or evenings of genial intercourse at his house in the Quantiusstrasse at Bonn. Absolutely devoid of any desire to pose before the public, the professor sometimes astonished students newly entered for his lectures by putting in a bit of humor where they had expected abstract instruction; but they soon found themselves none the worse for it. Some simple word, a casual remark made as if it were a self-understood thing, from his lips did more toward improving the mind of his audience than a long lecture from another. He was not a scientist inculcating one special branch of knowledge—he was a thinker. To be considered an authority, even by the youngest beginner, was an idea that never entered his mind. In the congenial atmosphere of advanced classes, new ideas and conceptions seemed to rise in him and flow from his lips as though there could be no easier thing in the world. He was at his very best when propounding a problem to this small circle, showing how he would attack it. None, however capable, but could profit by this teaching; genius itself seemed to prompt it.

With penetrating perspicacity he took hold of his problems. As a veritable disciple of natural science, he strove to accomplish his ideal ends, although by means of theory, which he completely mastered, yet not merely by theory and not for her sake only; what he aimed at first and last was the most accurate establishment of facts. Pervaded as his strong personality was by an absorbing love of his science, the rare harmony of his nature kept him equally from an exaggerated enthusiasm and from prosaic dullness. An uncommonly great number of valuable researches made at the Physical Institute at Bonn during the short time of his leadership prove his rare capacity and untiring eagerness to incite young talents to the best possible application of their faculties and so pave the way for their success in research. But in a wider sense of the word we may call his disciples all those physicists who are at this moment, and will be for a long time, occupied in exploring the provinces which he was the first to open. In this sense almost one quarter of all living physicists call themselves Prof. Hertz's followers.

The honors paid at his funeral to the memory of this young and ardent worker were exceptionally great. He was buried in his native city, Hamburg, where the most widespread sympathy for his family and the deepest regret over his loss were shown. From Bonn, Karlsruhe, and Berlin came friends, colleagues, and students, some of them officially representing their colleges. Universities and prominent men from all parts of our globe have sent messages of esteem and sympathy to the wife, the parents,

and the University of Bonn. It may be questioned whether such utterances of sympathy and respect, much as they tend to make mankind feel itself as one, can offer consolation to those whose bereavement is greater than words are able to convey. However, what Mr. Lowell said in one of his simple and admirable memorial addresses is certainly true:

"It may seem paradox, but the only alleviation of such grief is a sense of the greatness and costliness of the sacrifice that gave birth to it, and this sense is brought home to us by the measure in which others appreciate our loss."

Prof. Hubert Ludwig, of Bonn, uttered the last farewell at the grave of his friend and colleague. He expressed the sentiment of those grieving at his bier in these final words:

"This loss is so great that we are tempted to recall the old saying of the envy of the gods. But in this solemn hour let us resolutely banish such temptation, and instead of rebelling against destiny, let us at the open grave of this God-inspired investigator bow low our heads and hearts before the inscrutable."

THE importance of mountaineering from a geographical point of view, as is shown by Mr. Edward Swift Balch, in a paper on Mountain Exploration read before the Geographical Club of Philadelphia, is hardly understood by people in general. How much has been done by mountaineers from a geographical, a scientific, or an artistic impulse is hardly known, and the extent of field still open for mountain exploration and observation is not really appreciated. This field, represented by the mountains and mountain ranges in the five continents and the islands, covers something like one sixth of the globe. The first undoubted ascent of a glacier-bearing peak—that of the Buet, by Jean André and Guillaume de Luc, of Geneva, in 1770—was for the scientific purpose of making some experiments on the atmosphere for Jean André's book, Researches on the Modifications of the Atmosphere. The earliest ascents in central Switzerland were made by monks in the love of geographical exploration; and in the greatest of these monks, Placidus a Spescha, scientific knowledge and a love of mineralogy and geology were added to a desire to know the boundaries and the formation of the mountains with which he was immediately surrounded. Mont Blanc was first ascended, with scientific ends, by the geologist De Saussure. In the record of the contributions of mountaineering to science we have the studies of glacial phenomena and the forms of water in ice and snow and clouds, made with care and trouble by such men as Tyndall, Forbes, Agassiz, Escher von der Linth, and Guyot, who have camped out on some occasions for weeks at a time; and the famous expedition of 1842, when the movements of glaciers were practically first determined, and when the investigators from Neuchâtel lived on the ice for two seasons, under the protecting shelter of a bowlder, which became known as the "Hôtel des Neuchâtelois." The geology of the mountains and their botany and zoölogy have been studied. They have been utilized for astronomical and for weather observations; and the latest important attempt in this line is M. Jannsen's establishment of an observatory on the summit of Mont Blanc.

EDITOR'S TABLE.

THE FOUNDER OF THE POPULAR SCIENCE MONTHLY.

THE readers of this magazine will, we are sure, appreciate the satisfaction with which we have lately hailed the appearance of a biography, done by a most competent hand, of the late Prof. E. L. Youmans. This biography is one which all who were measurably acquainted with the late professor's work in the cause of science felt *must* be given to the world. Many biographies are not much more than tributes to the interest which a man's personal friends take in his character and career; but in the case of the late Prof. Youmans a chapter in the history of the intellectual development of this country would have been missing had his biography not been written. He came at a critical time; he was the man for the crisis; he saw his work, and he did it. That work was preparing the public mind on this side of the Atlantic for the reception of a new order of ideas in science and philosophy, and then transplanting those ideas into the soil so prepared. Prof. Fiske, whose literary skill never appeared to greater advantage than in the production of this biography, quotes a country clergyman as having said to him in 1857, "There is a great intellectual movement going on in Europe of which scarcely anything is known or even suspected in this country." The professor himself adds: "Lyell's great work on geology was published in 1830; a quarter of a century later I do not believe there were five men in our town who had ever heard of 'uniformitarianism'; it was only a very bold spirit that ventured to allude to the earth as more than six thousand years old. Science in general was regarded as a miscellaneous collection of facts and rules, some useful, some curious or even pretty; as for looking upon it as a vast coherent body of truths concerning the universe and its interdependent provinces, few minds, indeed, had grappled with such a conception." As late as the year 1860 one of the most enterprising and liberal publishing houses in Boston declined to republish Spencer's essays on education. "The Americans at that time," says Prof. Fiske again, "were excessively provincial. There was much intellectual eagerness, along with very meager knowledge."

Edward L. Youmans was born in the year 1821. We need not recite any of the incidents of his life, which are given in the most interesting manner by Prof. Fiske, and were also sketched last month in another department of this magazine. What we wish to point out is that, born in what his biographer calls a "provincial" society, he had an intellectual eagerness which was not satisfied with meager knowledge, nor yet with meager scientific conceptions. There was in him a singular and happy union of practicality and philosophic breadth. He was utilitarian in his aims, but he loved a wide expanse for his thoughts. Domestic economy was with him a favorite field of investigation and study, but at another moment he would take the keenest delight in seeing the plowshare of a vigorous criticism ripping up the clods of old philosophical systems. He did not himself claim to be an original investigator —nor does his biographer make the claim for him in any important sense; but he was ever on the watch for some enlargement of human knowledge or some improvement in the instruments of intellectual research. His was a pre-eminently open mind, and he loved science because, though it might have

at any given time its dark corners, there were no corners in it that had to be left dark, the constant effort of the scientific worker, in every portion of the field, being to get light and yet more light. He loved science because in studying it he breathed the air of liberty and became conscious of intellectual growth. No sooner had he emerged from the cloud which a prolonged period of alternately partial and total blindness had cast over his early life, than he betook himself to the lecture platform, and began, as his biographer expresses it, to "interpret science for the people." In this field he accomplished most useful work. Possessing, as he did, a wonderful gift of exposition, and having the kind of mind that naturally seized upon the most instructive and interesting aspects of things, he was able both to charm and to stimulate his audiences in an unusual degree. There was about him, too, a stamp of candor, of liberality, of noble-mindedness that must have exerted a powerful influence for good upon those with whom he came into contact. Science with him was not a trade, it was a vocation; and, obeying at every moment what seemed the highest call, he was ever ready to listen to a higher.

The higher call came with his first serious introduction to the works of Herbert Spencer. Long had he been feeling his way toward some more comprehensive scientific view than any he had yet grasped, seeking, if haply he might find, some common principle of interpretation for the infinitely diverse phenomena of the universe, when an article in a London periodical directed his attention to Spencer's Psychology. The study of this work, which he shortly afterward ordered from England, convinced him, as his biographer has expressed it, that "the theory expounded was a long stride in the direction of a general theory of evolution." His interest in Spencer was strengthened by a perusal of his Social Statics and of the valuable articles he was contributing at the time to the English quarterlies, particularly the Westminster Review. The biography tells how, when he found that Spencer had issued a programme or syllabus of his proposed system of philosophy, and was soliciting subscriptions thereto, Mr. Youmans wrote to him, expressing indebtedness for the advantage he had derived from the study of what he had already written, and offering any assistance which it might be in his power to render toward the success of the forthcoming volumes. Thus was the foundation laid of one of the most honorable, interesting, and fruitful friendships of which our times possess any record. On the one side, ardent and enthusiastic devotion to an intellectual leader whose teaching was looked upon as a message of transcendent importance to the present generation; on the other, a quick and generous appreciation of that devotion and of all the practical service to which it led. Those who have not yet read the biography, and may wish to see in what ample terms Spencer acknowledged the disinterested labors of Prof. Youmans in his behalf, can not do better than turn to the book and read Spencer's letters. It was certainly the opinion of the great English philosopher that Prof. Youmans, by his energy and zeal, his tact and persuasiveness and business sagacity, almost created a public for him in America; and, by the help and encouragement thus afforded, greatly contributed to the success of his works in England.

Having adopted Spencer as his leader, Youmans never faltered in his allegiance to him. It was a case of loyal following, not of blind partisanship; if any fuller light had shone into our late friend's mind, he could not have turned away from it; for that to which he was supremely loyal was the truth. But, in point of fact, he never saw anything else in the guise of philosophy which seemed to him to possess half the merit or value for mankind that he discovered

in the theory of evolution, as expounded by Spencer, and coupled by him with a strong assertion of the rights of the individual. Evolution as a world-grasping hypothesis, and "the law of equal liberty" as the charter of individual rights, made an absolutely irresistible appeal to the deepest instincts of the late Professor's nature; and it is no wonder, therefore, that in them he found an abiding anchorage.

We need only mention, in passing, the important work done by Prof. Youmans in arranging for the publication of the International Scientific Series, of which over seventy volumes have now been issued; but it is fitting that we should speak a little more fully on the subject of his establishment of The Popular Science Monthly. Even before he became interested in Spencer he felt that there was a great need in this country for a periodical which should be devoted to popularizing, not so much the results, as the methods of science. He was too much of a philosopher ever to forget that what the people want, far more than a diet of facts, is education in correct thinking, in the right use of their intellectual faculties. He fully believed, with Spencer, that natural science affords incomparably the best means of discipline for the mind; and after he had become impressed with the importance of that writer's general scheme of thought, he was more than ever desirous of establishing a magazine that might help in the propagation of sound scientific views. How suddenly in the end The Popular Science Monthly sprang into existence, the biography will tell; and on what sound lines it was drawn may be judged from the fact that in the course of twenty-two years those lines have never been departed from. The Popular Science Monthly is to-day what it was in the first year of its existence, and what its name imports. It is not intended for specialists, though specialists have made many valuable contributions to its columns. It aims to bring before intelligent readers the best and most interesting results of contemporary scientific activity, and to keep science as a power, as a method, as an inspiration, as the ally of humanity in its warfare against evil, prominently before the public mind. The magazine has had its own battles to fight, and, in its earlier years particularly, a good deal of misrepresentation to encounter. It has been accused of hostility to particular modes of belief, simply because it has wished to open paths of independent investigation in all subjects. It has, however, outlived most of the prejudice that at one time it excited, and to-day is welcomed in every part of the country as one of the most useful of educational agents, as affording just that aid to sound living and right thinking which it was the most earnest desire of its founder that it should afford.

To some it has appeared that the Monthly set too small value on literary culture, and that its late director was too contemptuous in his attitude toward classical studies. In all questions of this kind, however, a time element enters. Twenty odd years ago it was hard work to get any kind of proper recognition for science in schemes of education; and many sophisms that have since been exploded as to the necessity of the study of the classics for the formation of a good literary style, or for the right discrimination of words, or even for the proper development of the logical faculties, were then widely current and aggressively asserted. It was necessary, therefore, for a periodical that had been started with the express object of championing the claims of science, to put its own case as strongly as possible, and attack with vigor what it considered the errors of the older educational systems. If sometimes it pushed its criticisms too far, that is only what happens when any warfare is being keenly waged. That the founder of the Monthly was no enemy of culture in the widest sense, all who

were acquainted with him are well aware. In his youth he read even more of literature than of science. He had no acquaintance with the Greek or Latin classics in the original, but he read the best of them in translations, and with much enjoyment. His own literary style was a standing refutation of the plea that, in order to write good English, a man had to become familiar with Greek and Latin. It had the three great merits of accuracy, amplitude, and balance, and at times was even impressively eloquent.

Prof. Fiske has given a faithful presentation of the man, and it is not our purpose to add anything to his words of eulogy. Of no man can it be more truly said that his influence survives him. As the biography makes plain, he had a rare combination of qualities intellectual and moral, and he has laid an enduring impress, not only on the magazine which he founded, but on multitudes of minds with which he came into contact. The reason why he accomplished so much and wielded so great an influence may be found, we believe, in that disinterestedness which was one of his most conspicuous qualities. He was a true apostle, because he thought more of his cause than of himself. Had he thought more of himself, he might have been with us to-day; but who shall blame enthusiasm and devotion such as his? It led to oversight in matters pertaining to health, and that is to be regretted; but it stamped the man as one of the working, fighting heroes of the nineteenth century, and as such this generation will honor his memory.

LITERARY NOTICES.

THE MUMMY. CHAPTERS ON EGYPTIAN FUNERAL ARCHÆOLOGY. By E. A. WALLIS BUDGE. With Eighty-eight Illustrations. New York: Macmillan & Co. Pp. 404. Price, $3.25.

THE author of this work is acting assistant keeper in the Department of Egyptian and Assyrian Antiquities in the British Museum. The matter of it was originally written to form the introduction to the catalogue of the Egyptian collection in the Fitzwilliam Museum, Cambridge, and was intended to supply the information necessary for understanding the object and use of the antiquities described therein. It is hoped that it may likewise be of service to all persons interested in the antiquities of Egypt. It embodies the information which the experience gained from several years of service in the British Museum has shown to be the most needed by those who, though possessing no special knowledge of Egyptian antiquities, are yet greatly interested in them, or who have formed, or are about to form, Egyptian collections. Following up the idea that the mummy was the most important of all objects to the Egyptian, accounts are given of the various methods of embalming; of the amulets and other objects which formed the mummy's dress; of the various kinds of coffins and sarcophagi in which he was laid; and also of the most important classes of tombs hewn or built in different dynasties. These accounts are preceded by a satisfactory sketch of Egyptian history, with a list of the dynasties and of the cartouches of the principal kings, a list of the names, a chapter on Egyptian methods of writing, the Rosetta stone, etc., and are followed by descriptions of mummies, of animals, reptiles, birds, and fishes, and information concerning Egyptian months, Egyptian and Coptic numbers, and lists of common hieroglyphic characters and common determinatives. In a short space the book tells much about Egypt in a wholly acceptable way, and it may be regarded as one of the very best of the popular works on the subject.

THE JOURNAL OF PHYSIOLOGY. Edited in Co-operation with Professors W. RUTHERFORD, J. BURDON SANDERSON, and E. A. SCHÄFER, in England; H. P. BOWDITCH, H. NEWELL MARTIN, H. C. WOOD, and H. H. CHITTENDEN, in America; and T. F. A. STUART, in Australia, by MICHAEL FOSTER, M. D. Vols. XIV and XV. 1893. Cambridge Engraving Company, England. Price, $5 a volume.

THIS is the leading journal of original physiological research in the English language, and is devoted to the recording and illustration of the investigations of the most

eminent experimental physiologists of English-speaking countries. The two volumes contain more than thirty articles, with full details and graphical records of experiments continued in series and their results, relating to the nerves and nervous action, the heart, circulation, muscular work, digestion, the kidneys, animal temperatures, the secretions, mechanical action of the organs, chemical changes in the body and in its secretions, etc., and the chemical effects of various agents, action of drugs, salts, and other substances on various organs and their work, the senses and sensation, and other bodily functions and processes. The journal is a work of immense value to students and all interested in investigations in this field of research, and in the application of their results to the promotion of the health and vigor of the body and the lengthening of life.

THE ALCHEMICAL ESSENCE AND THE CHEMICAL ELEMENT: AN EPISODE IN THE QUEST OF THE UNCHANGING. By M. M. PATTISON MUIR. London and New York: Longmans, Green & Co. Pp. 94. Price, $1.50.

THE essence in old-time alchemistry, when contrasted with the element of the modern cult, can scarcely fail to excite an interest bordering on romance while retaining bounds strictly scientific in their nature.

The terse and entirely explicit volume before us presents the acceptable feature of uniting more closely some turning points between our acquaintance with modern chemistry and the visionary ground occupied by our forefathers, who long sought the unity of Nature in the — as yet — unfound philosopher's stone. When Thomas Vaughan, under the *nom de plume* of Eugenius Philalethes, wrote in the seventeenth century that Nature did not move "by the theorie of men, but by their practice," he pointedly foreshadowed and it mayhap unconsciously prophesied the achievements of modern chemical science. In this, as in numerous other phenomena, an inexorable though unseen law seems to wait upon all sincere effort to unbosom the secrets of Nature. When the anxious alchemist of a bygone age immersed his bar of iron in a solution of bluestone and, obtaining a deposit of copper upon the iron surface, announced that he had transformed the latter into the former metal, he mistook a seeming for an absolute truth; or, when in boiling water he discovered a residue of earth, and declared that he had changed water into mud, he simply lacked the instrumental means—the balance—to verify a whole instead of pronouncing a half truth. By such an experimenter, strange occurrences were not patiently dealt with, and a discovery was labeled prior to its meaning being known. A lack of delicate philosophical instruments retarded the advances of the alchemist at every step, and that he made any progress at all was mainly due to his incessant day and midnight vigils.

While the author of this entertaining volume records with care material facts governing ancient as well as modern chemistry, he admits the indefiniteness of the conception of unity in material phenomena, and intimates that, to at all come within reach of a definition of Nature's underlying essence, would be to know every detail of natural science, and indite a history of Nature itself. His essay is penned "in the hope" that such as exert their "wit and reason" regarding life's problems may help to solve Nature's questions and "those of her students who follow the quest of the unchanging."

PAIN: ITS NEURO-PATHOLOGICAL, DIAGNOSTIC, MEDICO-LEGAL, AND NEURO-THERAPEUTIC RELATIONS. Illustrated. By J. LEONARD CORNING, A. M., M. D. Philadelphia: J. B. Lippincott Company. Pp. 328. Price, $1.75.

To advance in some degree "the cause" of medical science is the sincere desire of the author in placing in the hands of students and physicians the above work, which to all intents and purposes bears upon its face the insignia of much thought and labor. In no special branch of medical treatment is the practicing physician more frequently called upon to exercise his wits than where pain is concerned, and for its alleviation the accurate diagnosis needed.

The book is divided into two parts; the first embracing pain in its physiological, pathological, and clinical relations. These are again subdivided into a definition, conduction, and physiology of pain. In treating of the pathology of pain no effort is spared to render lucid neuritis, or inflammation of the nerves, multiple neuritis,

chronic alcoholic neuritis, that of consecutive influenza, of beriberi, and the neuritis of leprosy. Under definite nerve areas, neuralgia is dealt with exhaustively and at length; also, rheumatic and gouty diatheses and the pains engendered thereby. Under Chapter VI, the diagnostic value of pain, as it deserves, receives that effective treatment so characteristic throughout the book of the author's predominant bent of mind.

Part II of the work takes up the special therapeutics of pain, and points to the importance of rest in the treatment of nervous symptoms engendered by prolonged and severe pain. Apart from the internal remedies directly or indirectly applicable in treating pain, the author proceeds to unfold his own methods in increasing the certainty and duration of several remedies and their action on the peripheral nerves, and goes on to expatiate upon the various surgical expedients not infrequently employed. The uses of compressed air in conjunction with remedies which tend to diminish the acuity of perception, including author's pain, come in for their quota of recorded observation, while prevention of relapse is noted fully and with precision. The closing pages supply some supplementary observations on torture and the infliction of pain as a judicial punishment during the middle ages in Europe.

Though cases that more properly belong to the domain of general surgery and medicine are not discussed by the author, the intricacy of the whole subject of pain is never lost sight of, and the vast array of pathological conditions treated assumes a character unquestionably of interest and high utility to the medical world.

A Student's Text-Book of Botany. By Sydney H. Vines. (First half.) New York: Macmillan & Co. Pp. 430. Price, $2.

This text-book has grown out of the author's labors in revising Prof. Prantl's *Lehrbuch der Botanik*, when the thought of extending the scope of that work was suggested. The extension went on till what is essentially a new and distinct work was produced. It deserves commendation for its thoroughness and the symmetry of its structure. The first part, now before us, is devoted to the exposition of morphology, a brief chapter on classification, and a description of the cryptogams. The province of morphology is defined to be "the study of the form of the body of plants, including the development of the body, the segmentation of the body into members, and the form and mutual relations of the members, as also the intimate structure (anatomy and histology of the body and its members in so far as structure throws light upon the morphology of any part of the body). It is an essentially comparative study." The two systems of classification—natural and artificial—having been distinguished, the natural system is defined as having for its object the classification of plants according to their fundamental relationships; and these being established once for all by Nature herself, it is not based on any arbitrary principle, but depends upon the state of our knowledge of these fundamental relationships. "These find their chief expression in the structure and other characteristics of the reproductive organs, as well as in the peculiarities of polymorphism presented by the life-history. This is more definitely true with regard to the definition of the larger groups of the vegetable kingdom; within these groups relationships may be exhibited sometimes in one way and sometimes in another, so that it is not possible to lay down any universal rules for determining close affinities. As the investigation of this subject is far from being complete, the natural system can not be regarded as being perfectly evolved; the various general sketches which have hitherto been given are therefore no more than approximations to the truth."

Man an Organic Community. By John H. King. London: Williams & Norgate. New York: G. P. Putnam's Sons. Two vols. Pp. 327+328. Price, $4.50.

We have here an effective work involving issues of prime import, as "an exposition of the law that the human personality in all its phases of evolution, both co-ordinate and discordinate, is the multiple of many subpersonalities." In each successive chapter the reader will discover clear conceptions fairly elaborated, and designed to prove the initial allegation which the author superadds to a law already recognized in the domain of science treated. By progressive

steps we are led to the pivotal idea through a radius of reasonings, from the simpler to the more complex forms constituting the human personality. Through this process the attempt is apparent to keep in a measure abreast of modern scientific research, and supply a truer interpretation of the meaning of human life. This, in turn, necessarily involves an ethical significance, not so much aimed at by the author as connoted by the reader in his perusal. Throughout the whole field of view selected, suggestions occur which mark a decided modification in, if not an entire elimination of, the popularly accepted idea of man's individual existence *in duo*. Withal, facts and ideas are so grouped as not to identify polemics with the object to be attained.

Among the more familiar doctrines treated of is that the real relations of things are not necessarily elucidated by, nor do they at all times express, their apparent conditions, more particularly so in the domain of natural phenomena. The belief in the homogeneity of man's personality received its primal shock and break when the differentiation of body and soul became an authorized concept in the past. Then, for the first, we discover a distinct personality expressed as attaching to the two entities. Organism and spirit had their distinguishing features and their separate functions, whether in union or disjoined. As with the mental attributes and moral affinities, any one of which might undergo change or be absolutely lost—as in numerous cases of insanity—so, though not in so marked a degree, a process distinct in character, supervenes the necessary changes which accompany growth outputs in the human organism, either marking secedence to senility, or the progressive steps to maturity. The human system, therefore, is no longer the self-contained individual, but each group of living activities within it has its special range of duties and relations, even down to the germ with its individualized potencies, which we discover only narrowly removed from the plasma. Hence we find in the human organic co-ordination, "not only the ruling and working subpersonalities of an individual character," but "the associate actions of combined and representative personalities the same as in a state; and, as in a state one personality may be attached to another as a check, so diverse organic attributes check other organic attributes and regulate the general equipoise by their varied interactions. As with the organic, so with the mental attributes."

Starting with the assumption that co-ordination, or growth combination, constitutes the governing principle of the human personality differentiated under distinct subpersonalities, the author proceeds to show that these latter in their content are but aggregates of a still lower class of differentiations. From the nomad to the man, this principle characterizes all growths. Further, while life exists these organic co-ordinations may separate or blend, and tissues are found to degenerate or advance, to be repellent or to severally work in unison. In each and every occurring and recurring complexity, however, the earlier differentiations which marked individual changes are never wholly forfeited; in brief, the evolutionary principle remains intact.

In Book I of the first volume we have inclusive the nature and origin of the human personality, the phylogenic stages of growth, the phylogenic sexual forms, and the co-ordination of faculties and functions. The forms of mental and organic co-ordination are covered by the second book under three classes and several chapters, all of which are written with a succinctness that sensibly diminishes the reader's labor, and include under "normal forms of co-ordination" the active wakeful state, quiescent repose, the state of reverie, somnambulism, and the induced mental and physical states. We gather from the "forms of co-ordinate variation" the law of variability in human personality, variations resulting from transference and variations through growth. From a review of the abnormal discordinate states, including physical abnormals and discordinations mental and organic, we are introduced to the second volume. This deals mainly with reversions to the lower civilized states, the semicivilized and barbaric states, the state of savages, and finally animal consciousness. Here the third and last book induces reflection on the internal and external relations of man, the modes of self-government in the co-ordinate personality, which betimes becomes alternate and multiple, and the power of self and external suggestion. In a lucid appendix,

wherein the unsolved problems of life are dealt with, we are led to a clearer apprehension of what we do not, rather than what we do know concerning the insoluble. This, in the light of certain—to compound a term—scio-dogmatic allegations extant, is at least refreshing, if not entirely novel.

LEGENDS OF THE MICMACS. By the Rev. SILAS TERTIUS RAND. Wellesley Philological Publications. New York: Longmans, Green & Co. Pp. 452.

THESE legends, which are published under the direction of the Department of Comparative Philology of Wellesley College, were collected by Dr. Rand during the forty years of his service as a missionary among the Nova Scotia Indians from whom they are derived. The stories were related to him in Micmac, by the native Indians, and were then translated and written down by him in English. The original manuscript is a volume of nine hundred quarto pages. A few of the legends have already been published —in the Dominion Monthly and the American Antiquarian; and some have been used and cited from in Mr. Leland's Algonkin Legends and in Mr. William Elder's article in the North American Review on the Aborigines of Nova Scotia. Dr. Rand is quoted as saying, concerning the origin of these stories and their relationship to European tales and myths: "I have never found more than five or six Indians who could relate these queer stories; and most if not all of these are now gone. Who their original author was, or how old they are, we have no means of knowing. Some of them are evidently of modern date, because they refer to events that have taken place since the advent of the whites. Some of them are so similar to some of the old European 'fairy tales' and 'wizard stories' in our English story books as to lead to the impression that they are really one and the same." Mr. Leland has noticed some curious coincidences between the Norse myths and those of the Wabanaki or northeastern Algonkins, to which branch the Micmacs belong, and inclines toward an explanation of the resemblances by the theory of direct transmission. Dr. Rand's biographer gives him the credit of being the discoverer of Glooscap, a mythological character which Mr. Leland calls "the most Aryan-like of any ever evolved from a savage mind," and with having saved from oblivion the mythological lore of a people that are losing with every generation their hold on customs and manners. Prof. Horsford, of Wellesley College, took a great interest in the publication of this work; and the editing of it for publication has been done by Helen L. Webster.

ALTERNATING CURRENTS: AN ANALYTICAL AND GRAPHICAL TREATMENT FOR STUDENTS AND ENGINEERS. By FREDERICK BEDELL, Ph. D., and ALBERT CUSHING CREHORE, Ph. D. New York: The W. J. Johnson Company (Limited), 41 Park Row. Pp. 325.

As precluding the necessity for further search after a certain class of handbooks on alternating currents the present work, designed to answer any query from the simplest to the most complex, will amply repay a careful perusal. A thousand and one interesting comparisons recur within its pages, and it abounds with easy solutions to technical problems. It is a consistent application of the modern method of solving things easily, and many of our educational series are wisely adopting a similar course. As the authors suggest, the principles underlying the subject need clear elucidation, more particularly as incessant advances in the utilization of alternating currents and the apparatus employed are, and with pronounced effect, hourly coming to the front. The comparative newness of the theory regarding these currents has attracted the attention of electrical engineers from all quarters, so that any problem one might select has already been fully treated by known writers. Still, nearly the whole bulk of solutions extant, apply in most instances to special cases. From this fact has arisen the desire to have the subject treated generally.

The work is divided into two parts. The first is entirely analytical in its nature, and the second is mainly graphical. Circuits involving resistance and self-induction are minutely considered, and the elementary principles establishing the equation of energy are dealt with as founded upon the experiments of Faraday, Coulomb, Ohm, and Joule. From this it is manifest that no previous knowledge of electricity or magnetism is necessary in order to grasp the solutions

given. Throughout the second part the same order prevails as obtains in the first, and the treatment of problems concerning simple circuits embracing self-induction and resistance is extended to the like, as involve combination circuits and their phenomena. Then such problems are treated as include simple and combination circuits having capacity and resistance, but void of self-induction. Also, such circuits as contain capacity, resistance, and self-induction, together with combined and parallel circuits.

The present is a second edition of the work, on which much care has been bestowed with the view of eliminating errors that unavoidably crept into the first issue. Toward the close of the first part some intensely interesting and instructive paragraphs occur on wave propagation in closed circuits, showing the vanishing attitude of positive and negative waves and the resulting effect, the potential zero at middle point in the cable, and proving that the expression for potential may be simplified if the cable's length should happen to be a multiple of wave lengths. The structure of the volume is admirably suited to students, as any problem needed may be readily found.

ART IN THEORY: AN INTRODUCTION TO THE STUDY OF COMPARATIVE ÆSTHETICS. By GEORGE LANSING RAYMOND, L. H. D. New York: G. P. Putnam's Sons. Pp. 266. Price, $1.75.

THE essential idea, if not the sole aim of this volume, is the application of the term *representative* to all art forms, whether of word or deed; the representativeness to include more than the limitations hitherto placed upon it by certain English art critics, and such as make a further distinction between what they term presentative and representative art. Indeed, the author's effort is entirely legitimate, and scores an advance upon the many imitative if not conventional so-called art criticisms extant. It is invariably refreshing to encounter any original subtlety of sense attaching to a new or augmenting an old idea, and in Prof. Raymond's book the true art of judging "Art in Theory" is not lacking. As the author intimates, works of art are the products which reveal the methods of the artist, whether he desires to represent a thought or a thing—to produce effects of any kind whatsoever. A courageous and justifiable departure on the part of Prof. Raymond is, where he breaks away from the historico-critical method of regarding art and its influence as an æsthetic factor. Duly crediting historic criticism, however, for its inestimable services in all other departments, he goes on to show that as the arts are affected by laws of development, more especially the higher arts, these latter are very often distinctly not expressive of the spirit of the age. Precisely, and for the unfortunate reason that conventionalism controls them. The historian claims what is not true when he alleges that all art is deserving of study. To the artist as an artist it is not. That art which has attained a high level of excellence is of interest to him, and very often to him alone. Hence, the great artists' methods are not infrequently misinterpreted in their day. The æsthetic power that distinguished the work of an Aristotle, a Confucius, an Angelo, or Shakespeare had not its immediate influence for the now manifest reason that they were moved as much, at least, by the spirit interpreting within them as by the conventionalities that made demands from without.

Whether we contemplate one or more of the twenty brilliant chapters within this volume, involving either the significance of form in art, classicism and romanticism, the art-impulse, taste, theories concerning beauty, or any one of the many features so pregnant with suggestion we feel assured that readers will acknowledge their introduction to an author not bound by mental servitude.

AN EXAMINATION OF WEISMANNISM. By G. J. ROMANES, M. A., LL. D., F. R. S. Chicago: The Open Court Publishing Co. Pp. 221. Price, $1.

THE object of this volume is tersely stated in the author's words—to separate the grain of good science from the chaff of bad speculation. This winnowing process, when closely followed, proves to be highly interesting. Dr. Romanes gauges his separator to meet Weismann's great doctrines of the *perpetual continuity* and *unalterable stability* of germplasm, and when at last, with relentless logic, he has sifted out every extraneous speculation, and holds these theories in his grasp to demolish them, the wise and wary Weismann

announces that upon further investigation he believes that germ-plasm is *universally unstable!*

When this recantation occurred, Dr. Romanes considered for a while whether he should cancel the first two chapters of this book already prepared for publication. He concluded, however, to let them stand, justly observing: "It is open to question whether an author of any kind should suffer an elaborate system of theories to be published and translated at the very time when he is himself engaged in producing another work showing the untenable character of their basal premises. . . . At the least he should have added notes to his Polar Bodies and Amphimixis to let the reader know his change of doctrine."

It might be supposed when these leading features were stricken out from Prof. Weismann's theories of descent and evolution, the remainder would be characterless. But the fanciful mechanism of heredity was retained, the difference in mortality between the Metazoa and Protozoa was emphasized, and the instability of germ-plasm was confined to the least possible degree, still making amphimixis the main cause of variation. This disturbed Dr. Romanes more than all else. He chafed at "a germ-plasm that is both stable and unstable at the same time," and writes, "It is this half-turn to which I object, as unwarranted in logic and opposed to fact."

The subject of the inheritance of acquired characters, associated with the name of Weismann, is not taken up by the author of this dissertation, except incidentally, but is reserved for a future volume, when it will be discussed as a matter of fact. The major part of the book is devoted to a consideration of Weismann's theories in comparison with the hypotheses of Darwin and Galton.

According to Darwin the substance of heredity, *gemmules*, may be formed anew in each generation; is discontinuous, and proceeds from the somatic to the germ cells, i. e., centripetally, whence the inheritance of acquired characters is habitual.

With Galton the substance of heredity, *stirp*, is mainly continuous; proceeds from germ cells outward to somatic cells, or centrifugally. Acquired characters are rarely inherited.

Weismann taught that the substance of heredity, *germ-plasm*, was perpetually continuous; proceeded from germ cells to somatic cells, centrifugally. Acquired characters can not be inherited.

With the modifications recently made, this theory substantially coincides with Galton's. Originally, Weismann held that the sphere of germ-plasm was entirely restricted and localized; that there was no reciprocal action between it and body substance; but afterward, upon being confronted with the botanic phenomena involved in cutting, budding, and graft-hybridization, he allowed that germ-plasm might be found in the nuclei of somatic cells, diffused in the cellular tissue of plants.

Wrapped up also in the tenet of unalterable stability was the origin of hereditary individual variation, which was thus referred to the Protozoa, amphimixis being the only possible cause of congenital variation among multicellular organisms.

In the germ-plasm these dogmas were molted as follows: "The cause of hereditary variation must lie deeper than this. It must be due to the direct effects of external influence on the biophores and determinants; . . . the *origin of a variation* is equally independent of selection and amphimixis, and is due to the constant occurrence of slight inequalities of nutrition in the germ-plasm."

These sentences, which undo so much of Weismann's distinctive theories, were, according to Dr. Romanes, unnoticed by most of his critics. It may be added that the differentiation of doctrine is thus reduced to *centripetal heredity*, Galton and Weismann; *centrifugal heredity*, Darwin and Spencer.

Weismann's mechanism is extremely elaborate, including nine circles of germ-plasm: molecules, biophores, determinants, ids, idants, idioplasm, somatic idioplasm, morphoplasm, and apical plasm. Of these hypothetical divisions Dr. Romanes would adopt the ids and determinants, since it is a group of cells rather than a single cell that varies in descent.

Two appendices are added to the book. The first contains an argument as to whether a centrifugal theory, germ-plasm, is more conceivable than a centripetal one, pangenesis. Dr. Romanes concludes that one is no more imaginable than the other; "that, whatever the mechanism of heredity may be, it is at

once so minute and complex that its action is inconceivable." Appendix II is devoted to a discussion of telegony, much of which has appeared in this magazine. Dr. Romanes believes in centripetal heredity, and therefore can not agree with Mr. Spencer, whose theory is of the centrifugal order.

ELECTRIC WAVES: BEING RESEARCHES ON THE PROPAGATION OF ELECTRIC ACTION WITH FINITE VELOCITY THROUGH SPACE. By Dr. HEINRICH HERTZ. London and New York: Macmillan & Co. Pp. xv + 278. Price, $2.50.

THE impossibility of reviewing in brief a work of such transcendent importance to electrical science as this volume undoubtedly is, will become apparent to the reader when we declare that the progress—exclusive of the author's own discoveries—so concisely recounted, not only embraces the names and experiments of and from Newton and Bernoulli and their day, down through a line of seventy-five prominent men of genius, but also includes with Faraday and Ampère—of late years—Helmholtz, Lodge, Maxwell, Siemens, and Sir W. Thomson in our own day. The volume before us is the authorized English translation from the German work, by Prof. D. E. Jones, B. Sc., and includes an able preface by Lord Kelvin, President of the Royal Society.

Dr. Hertz was primarily induced to carry out the experiments elucidated in this volume through the proffered prize in 1879 of the Berlin Academy of Science, for a solution of the problem to establish by experiments "any relation between electromagnetic forces and the dielectric polarization of insulators," which simply meant that a force electromagnetic in itself might be exerted in non-conductors by polarizations, or that electromagnetic induction is the cause of the polarization of a non-conductor. The attention of the professor was first drawn to the problem by Herr von Helmholtz, who promised the assistance of the Physical Institute in Berlin if Dr. Hertz determined upon making the research and necessary experimentation. After many failures, and his first abandonment of the solution, he finally gives to the world the impressive deductions of the original papers—now in the form of fourteen chapters—contributed to Wiedemann's Annalen. These are, in the present volume, supplemented by an ample introduction and various explanatory notes of vast import. Proceeding from the introduction, which emphasizes the experimental and theoretical phases of the subject, we gather from chapter to chapter the crowning results embodied in such phenomena as rapid electric oscillations, the effect of ultra-violet light upon the electric discharge, the action of rectilinear electric oscillations upon a neighboring circuit, the finite velocity of propagation of electromagnetic actions, electric radiation, the fundamental equations of electromagnetics for bodies at rest, and other all-important subdivisions. The work in the aggregate represents the fervid expression of a scientific explorer, whose heart was indubitably in his work, and who now presents us at minimum cost a wealth of labor and a store of new knowledge.

ROMANCE OF THE INSECT WORLD. By L. N. BADENOCH. New York: Macmillan & Co. Pp. 341. Price, $1.25.

THIS volume contains one of the best efforts that have been made recently to put scientific facts into an attractive form. If one can be interested at all in the wonderful ways of insects, this book will spur to better acquaintance. Valuable data have been culled from every quarter, not neglecting the investigations of our American naturalists, Dr. McCook, Mrs. Treat, and the Peckhams. These are grouped under the four topics of metamorphoses of insects, their food, home-building, and defenses.

The transformations of insects, although seemingly abrupt transitions, are but progressive stages toward maturity, mainly due to the nature of an insect's skin, which does not permit enlargement of form.

The bill of fare relished by insects exceeds in variety that demanded by the larger members of the animal kingdom. Anything from a nettle to a fungus may be acceptable, horn, cork, or grease being the favored diet of some species. There is also a long list of insects that are parasitic, and others who breed their own cattle.

Among those who build hermit homes are described the mining, carpenter, and mason bees; the wasps, making nests of clay; the gall-makers; the lictor moths that carry their curious dwellings about with them, and the

ingenious spiders who build trapdoors and turrets. Social homes are those of the mason, carpenter, and leaf-cutting ants; of the wasps manufacturing paper and cardboard, including the Nectarinia that construct globular nests with a spiral flight of stairs.

Thousands of insects possess no other defense than their protective resemblances. Other classes decoy their prey by simulating some alluring object. Under the head of variation of color some account is given of the experiments in regard to larval susceptibility. Brightly colored insects find protection in a nauseous taste or smell, irritating hairs or spines, the power to discharge a noxious fluid or inflict a sting. Insects otherwise defenseless escape their foes by mimicry of the behavior and appearance of distasteful species. This curious phase of insect life is considered at some length in the closing chapter.

The book is well illustrated, and contains both glossary and index.

DARWIN AND HEGEL: WITH OTHER PHILOSOPHICAL STUDIES. By DAVID G. RITCHIE, M. A. London: Swan, Sonnenschein & Co. New York: Macmillan & Co. Pp. 285. Price, $1.50.

THE results of the reasonings submitted in the nine essays constituting this volume may be regarded as having arisen from a judicious survey of the branches of philosophy treated. That on Darwin and Hegel, as the author explains, has been selected as the title of the work, because it emphasizes more particularly the especial point of view, or basic relations which form a juncture in the criticisms under consideration. This is certainly the pivotal essay as tending to reconcile a measured acceptance of the "general principles" arising out of Kantian criticism, which governs that idealist philosophy originating with Plato and Aristotle, with an acceptation in the fullest of the intellectual advances made by, residing in, and betimes overlying the historical method of treating institutions and ideas; as well as the theory of natural selection and its logical outcome.

The papers now published in bulk originally appeared in Mind, are recorded in the Proceedings of the Aristotelian Society, The Annals of the American Academy of Political and Social Science, and other periodicals. Regard this book in whatever light acknowledged scientific data may shed, evidence is not lacking of Mr. Ritchie's logical acumen, linked with a genuine spirit of inquiry. In the general presentation of the author's position, these essays, if only cursorily read, might seem totally isolated, whereas a careful perusal reveals a well connected thought undercurrent. The true worth of the volume is best attested by the number of considerations posited in the form of queries, not a few of which are solved outright in Mr. Ritchie's own way, while others remain to be determined by the reader or the future philosopher. Besides the main essay, forming the title, we have one on Origin and Validity, which involves a briefer paper on Heredity as a Factor in Knowledge. The others following are, What is Reality? On Plato's Phædo; What are Economic Laws? Locke's Theory of Property; The Social Contract Theory; On the Conception of Sovereignty, and the Rights of Minorities.

In his analysis of the philosophies of Darwin and Hegel, as applied in their social and scientific bearings, the author intimates that while materialism and idealism are ordinarily referred to as philosophically antagonistic, he nevertheless endeavors to prove that a certain "form of idealism" is not at all incompatible with that monism of materialistic teaching which has nowadays become "the working hypothesis of every scientific explorer." To Mr. Ritchie the monism of materialism alone seems false when posited as an absolute philosophy of the universe. From this he is forced to infer that any such doctrine will necessarily put out of sight conditions of knowledge which true philosophy must not ignore, though the special sciences may. In the paper on Origin and Validity as applied to philosophy, the cords that bind a certain class of popular dogmas presumed to determine real worth Mr. Ritchie severs with relentless logic, and then proceeds with marked caution to distinguish between the philosophical problem and that of psychology and history. Dilating upon what he considers most permanent in Kant's Critical Philosophy, he proposes to examine the relation existing between speculative metaphysics and Kant's theory of knowledge, and supplies not a few illustrations of the import attaching to the distin-

guishment in logic of questions of origin and validity. The difference between reality as understood in ordinary belief, and as the term is applied to science, is very definitely dealt with in the essay on What is Reality? also the query as to whether our feelings are more than our thoughts, and if space is actually occupied by the real. On the Phædo of Plato, the most interesting of the critical examinations apply to the distinction that ought to obtain between Plato's teachings as understood by himself, and as they are subsequently developed and interpreted by Aristotle. Comparing the arguments of the Phædrus with those of the Phædo, some technical points arise in the mind which Mr. Ritchie deems worthy of especial comment. Some striking objections to the position of Economics considered in its relation to the sciences are concisely recounted, and in Locke's Theory—property—the author suggests an interesting study on the theories of Hobbes and Locke in the light of events current in their day.

When the work is considered as a factor in modern research, each page and paragraph may be regarded as a brief historical and critical key to a few of the most striking questions engaging students of evolutionary philosophy.

DICTIONARY OF THE ACTIVE PRINCIPLES OF PLANTS; ALKALOIDS; BITTER PRINCIPLES; GLUCOSIDES: THEIR SOURCES, NATURE, AND CHEMICAL CHARACTERISTICS, WITH TABULAR SUMMARY, CLASSIFICATION OF REACTIONS, AND FULL BOTANICAL AND GENERAL INDEXES. By CHARLES E. SOHN, F. I. C., F. C. S. London: Ballière, Tindall & Cox. Philadelphia: J. B. Lippincott Company, 1894. Pp. vii + 194. Price, $3.

THE present work treats of nearly six hundred alkaloids, glucosides, and bitter principles, and it has been prepared in order that the details relating to these substances, now more or less scattered through chemical literature, should be so tabulated that not only a given attribute of any substance shall be readily found, but that there shall be information indicating wherein such a substance differs from, or resembles, another of its class.

The work is arranged in three parts: The first groups together the constituents of one plant or of a number of botanically or chemically allied plants, following as far as possible an alphabetical order. The second part consists of a tabular summary designed for ready reference as well as for contrasting one compound with another for analytical purposes. The third part is a classification of reactions for the special use of analysts.

There is a complete botanical as well as a general index to the volume. It is likely to prove a convenient work for the pharmacologist as well as the chemist.

A Treatise on Elementary Hydrostatics has been prepared by *John A. Greaves* (Macmillan & Co., New York, $1.10) with the purpose of treating the subject as fully as possible without using the calculus; but alternative proofs have been given where the calculus enables us either to obtain the results more easily or to express them more concisely. Having shown that solids may be classified according to their behavior under the action of forces, the author deduces the definition of a fluid from the characteristic behavior of all substances which we recognize as fluids. The special chapter headings are the Properties of Fluids, General Theories relating to Pressure, Center of Pressure, Floating Bodies, The Determination of Specific Gravity, Gases, Hydrostatic Machines, and Capillarity. In the last chapter it is shown from experiments that the energy of a material system depends partly on the extent of the surfaces separating the different substances. On the assumption of the existence of this surface energy, several well-known capillary phenomena are deduced.

For some time past it has seemed to *G. A. T. Middleton* that a concise work upon land surveying, in which modern instruments and modern methods of working were described, would be welcomed by many. The result has been the production of a small volume on *Surveying and Surveying Instruments* (Macmillan & Co., New York, $1.25), the substance of which has already appeared in a technical journal. It includes chapters on Surveys with Chain only, Obstructions in Chain-line and Right-angle Instruments, The Uses of the Level, Various Forms of Level and their Adjustments, The Uses of Angle-measuring Instruments, The Theodolite and other Angle-measuring Instruments, and Instruments for ascertaining Distances.

Twin manuals on *Heat* and *Light* have been prepared for the Cambridge Natural Science Series (Macmillan & Co., New York, $1 each), by *R. T. Glazebrook*, as elementary text-books, theoretical and practical, for the purpose of serving as aids in teaching by experiments that may be performed by the pupils themselves. Most of the experiments described have been in use for some time as a practical course for students in the Cavendish Laboratory. The rest of the two books contain explanations of the theory of the experiments and accounts of the deductions from them, which have formed the substance of the author's lectures to his class.

The general purpose sought by *Henry Wood* in preparing the *Political Economy of Natural Law* (Lee & Shepard, Boston, $1.25) was to outline a political economy which is natural and practical rather than artificial and theoretical. While independent of professional methods, it aims to be usefully suggestive to the popular mind. The present volume, though substantially a new work, may be regarded as a development from a small book entitled Natural Law in the Business World, published in 1887. A portion of the original matter in that book has been retained, somewhat changed in form. No attempt is made to make people content with things as they are, but to turn the search for improvement in a promising direction. We are glad to see that the author sets himself squarely in opposition to the fallacy that the interest of labor is naturally antagonistic to other social elements, which he thinks justly has done much harm.

After the Congress of Mathematics, held in Chicago, in August, 1893, a *colloquium* on Mathematics was held by Prof. *Felix Klein*, of the University of Göttingen, with such other members of the congress as chose to participate, at the Northwestern University, Evanston. During these colloquia Prof. Klein delivered daily lectures, the substance of which was taken down and prepared for publication by Alexander Ziwet. These lectures are now published as a single volume of *Lectures on Mathematics* by Macmillan & Co., New York ($1.50). Three of these lectures relate to the work of the mathematicians Clebsch and Sophus Lie; the others are on The Real Shape of Algebraic Curves and Surfaces, Theory of Functions and Geometry, The Mathematical Character of Space Intuition and the Relation of Pure Mathematics to the Natural Sciences, The Transcendency of the Numbers e and π, Ideal Numbers, The Solution of Higher Algebraic Equations, Some Recent Advances in Hyperelliptic and Abelian Functions, The Most Recent Researches in Non-Euclidean Geometry, The Study of Mathematics at Göttingen, and The Development of Mathematics at the German Universities.

Mr. *Charles H. Clark* has prepared his book on *Practical Methods in Microscopy* (D. C. Heath & Co., Boston, $1.60) in view of his observation that in most of the excellent current books on the microscope too much is assumed to be known by the pupil, or is left to be filled in by an instructor. None of them, he says, gives to the private worker in simple and concise language detailed directions for the many processes that he must learn in order to make practical use of the microscope. The present book is the outgrowth of the author's experience in the use of the instrument in the branches of scientific study pursued in the secondary schools. So much of the mechanical construction of the microscope is given as seems absolutely essential to an intelligent understanding of the instrument. The theory of polarized light has been somewhat fully considered.

The peculiar features of the *Practical Business Bookkeeping by Double Entry* (D. C. Heath & Co., Boston, $1.55), as set forth by the author, *Manson Seavy*, are classification of the subjects treated into parts, each forming by itself an independent whole, with subdivisions; full and systematic treatment, with illustrations of recounts; omission of discussion of theory; the acceptance of the forms universally adopted by the best business men and accountants in the treatment of business transactions; full discussion of bills receivable and bills payable; and the original, simple, and intelligible rules given for closing a ledger, which have stood the test of many years with classes of young students. The work is supplemented by another, The Manual of Business Transactions, which contains transactions only, in the describing of which the student must exercise his own judgment, and thus acquire proficiency in the application of principles.

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POPULAR MISCELLANY.

Meeting of the American Association.—The forty-third meeting of the American Association for the Advancement of Science will be held in Brooklyn, N. Y., August 15th to 24th. The names of the officers were given in The Popular Science Monthly for October, 1893. The rooms of the Polytechnic Institute, the Packer Institute, the Art Association, the Long Island Historical Society, and the Academy of Music have been offered for the use of the association. The meetings will be held mainly in the buildings of the Polytechnic and Packer Institutes. The headquarters of the association will be at the St. George Hotel, Clark Street. The Ladies' Reception will be given August 16th. An unusually varied and attractive list of excursions is offered, including free excursions to Long Branch; Cold Spring Harbor, Long Island, where are the Biological Laboratory of the Brooklyn Institute and the station of the New York Fish Commission; up the Hudson to West Point and return; and around the harbor; geological excursions to six points of interest; mineralogical excursions to six points; botanical excursions to five points; zoölogical excursions to four points; excursions for engineers to the Navy Yard and the Brooklyn Bridge; and an excursion to the White Mountains to attend the Congress of the American Forestry Association. The pay excursions will be at reduced fares. The meetings of the associations and societies affiliated with the General Association will be held before and during its meetings, beginning with those of the Geological Society of America and the American Microscopical Society, August 13th.

Classes in Economics.—Instruction in the Department of Economics in the School of Applied Ethics, Plymouth, Mass., during the session July 12 to August 15, 1894, will be devoted to a discussion of the relation between economics and social progress. The idea which underlies it is, that all phases of social activity and living are necessarily bound together, and consequently that no problem in which human relations are a prominent factor, whether theoretical or practical, can be properly understood, except it be studied in the light of some comprehensive theory of social development. The same general purpose will be recognized in the adjustment of courses in the other departments of the school, which include those of History of Religious and Applied Ethics. The scheme of lectures includes courses by Prof. H. C. Adams, director, on the Historical Basis of Modern Industries, Relation of Economic Theory to Social Progress, and The Transportation Problem; by Prof. J. B. Clark, on The Ethics and the Economics of Distribution; by Prof. R. Mayo-Smith, on Ethnical Basis for Social Progress in the United States; by President E. B. Andrews, on Civilization and Money; their Relation illustrated by the History of Money; by Prof. F. H. Giddings, on The Social Functions of Wealth; by Prof. J. W. Jenks, on the Relation of Political and Industrial Reform; and by Dr. E. R. L. Gould on Practical Problems in Municipal Economy.

The Benefits of Sanitation.—A paper on The Achievements of Sanitation measured by Vital Statistics, by George E. Willetts, of Lansing, Mich., contains some suggestive data bearing on the usefulness of modern sanitation. Having sought for some compilation of death-rates from a number of the principal diseases reaching back for so long a period as to tell a connected story concerning such diseases, without being able to find it, Mr. Willetts carefully worked out the subject himself from selected data relating to mortality from fevers, cholera, consumption, smallpox, and all causes as recorded

in the death-rates of England, Sweden, the city of London, etc. The result is a demonstration of the alteration for the better that has taken place in modern times in the rate of mortality from these causes. Diagrams prove graphically that a marked diminution in the death-rate has taken place, especially in the last half century, or since the efforts at prevention and restriction of infectious diseases have become systemized. Facts are brought out in Mr. Willetts's presentation showing that the theory of M. Carnot, that the saving of life from infectious diseases is only apparent, and is made up for by an increased mortality from certain other causes of death, is untenable, for the death-rate from all causes declined during the period under examination. The doctrine of Malthus, likewise, that the effect of diminution of the death-rate is to cause the population to press more closely upon the limits of subsistence, is negatived by the fact which appears that the rate of pauperism has declined in England coincidently with the fall of the death-rate. It also appears that the population is increasing least rapidly where good sanitary conditions have prevailed. The effect of sanitary improvement is thus seen to lie, not in the direction of an over-production of the human race, but toward a better regulated and governed increase.

Expansion in Public Documents.—The latest report of the State Mineralogist of California furnishes an interesting object lesson as to the manner in which literature is prepared at the expense of the Government. The report relates, or is supposed to relate, to mining. The Governor of the State, in his message, objected to the voluminousness of this as well as some of the other department reports, saying that none but the unemployed and those directly interested and expecting to derive personal benefit from them could find time to read them; intimating that too little time was devoted by their authors to condensing their statements; and suggesting that while the printing of the mineralogical report would cost ten thousand dollars, "two thousand dollars worth of intelligent editorial work bestowed upon the manuscript would have saved four times that amount in the cost of printing, and the volume would have been of greater value to those interested. People," he added, "will not read long, tedious reports, and if it were not for the condensed statements given out through the press the people of the State generally would have very little information in regard to our public institutions." An appropriation having been made for the purpose, the material was put into the hands of an editor for condensation. He found several of the articles that had been prepared not directly related to the subject, though possibly of scientific value and doubtless suitable for publication through other channels, such as an academy of sciences, a geographical or an ethnographical society. In some cases the same ground was covered by the special reports of two or more assistants; in other cases matter was substantially repeated from previous reports, while no attempt had been made in either category to prune any excrescences. The manuscript showed no signs of having been edited, aside from the mere paging of the leaves and arranging in order. In parts of the manuscript that had been copied in the office, errors of copyists entirely unfamiliar with mining affairs had been retained without revision or attempt to correct them. Finally, the editor reduced the 2,307 pages of manuscript, largely type-written, to about 844 pages, or 954 pages if an article on mining law, valuable but not relating exclusively to California, is retained; and in doing this believes that he has retained all the matter proper for the report. This excessive expansiveness is not found in the public documents of California alone. We have observed it in those of the United States in more than one department.

The Soda "Lake" of Wyoming.—As described by H. Pemberton, Jr., and George P. Tucker, there exists a deposit of sulphate of soda, locally known as a "lake," about fourteen miles southwest of Laramie, Wyo. The deposit is composed of three of these lakes lying within a stone's throw of one another—the Big Lake, the Track Lake, and the Red Lake—having together a total area of about sixty-five acres. They are the property of the Union Pacific Railroad Company, are connected by a branch of that road with the main line at Laramie, and are generally known as the Union Pacific Lakes. In these lakes the sulphate of soda occurs in two

bodies or layers. The lower part, constituting the great bulk of the deposit, is a mass of crystals of a faint greenish color, mixed with a considerable amount of black, slimy mud. It is known as the "solid soda," and is said to have a depth of some twenty or thirty feet. Above this solid soda occurs the superficial layer of pure white crystallized sulphate of soda. This is formed by solution in water of the upper part of the lower body, the crystals being deposited by evaporation or by cooling, or by the two combined. A little rain in the spring and autumn furnishes this water, besides which innumerable small sluggish-flowing springs are present in all the lakes; but on account of the dry air of this region the surface is generally dry, or nearly so, and in midsummer the white clouds of efflorescent sulphate that are whirled up by the ever-blowing winds of Wyoming can be seen for miles. The layer of white sulphate is from three to twelve inches in thickness. When the crystals are removed, the part laid bare is soon replenished by a new crop.

The Tea Gardens of Johore.—Johore is an independent kingdom—the only one now in the Malay Peninsula—on the Strait of Malacca, and fourteen miles from the British colony of Singapore. It is one of the richest native states in Asia—rich in its deposits of tin and iron, and in its virgin forests of valuable tropical trees, and in the productive capacity of its soil. The present sultan, Abu Bakar, has experimented liberally in the development of the native crops of tapioca, cocoa, sago, gambier, spices, and gums, and has introduced the cultivation of tea, coffee, and pepper with such success that they now form the chief products of the kingdom. The Johore tea has been declared by experts to be of a very superior quality. The moist heat required by the tea plant is afforded in such perfection by the climate of Johore that the plants flush, or afford the fresh shoots from which the young leaves are picked to make our tea, all the year round. The bushes are planted in rows about five feet apart, with a space of about five feet between the stools. Each bush flushes about three times a month; and once a year it flowers, and is then pruned. The leaves are picked by Chinese or coolies, who turn in their pickings twice a day, and are paid by the piece. An industrious picker can pick, when the flush is good, as much as sixty pounds of green leaf a day, which will make a little more than fourteen pounds of dried leaves. The green leaves are carefully "withered" in bamboo trays by experienced Chinese operators till they are sufficiently dried—a fact which is determined by the touch; they are then rolled, either by hand rollers or rollers worked by steam, in such a way that they are pressed and twisted without losing juice. After this they are placed in heaps upon a bench, where they are turned over and over again by hand, to be "fermented," till they lose their original green and become blue; thence they are removed to a large drying chest called a sirocco, and exposed to a heat of 260° F. Each sirocco will hold four trays, which are placed at different levels. The first batch of leaf is placed on the top tray, and after a few minutes is withdrawn, turned over by hand for a while, and is then placed on the second tray, while the first tray is filled with a new lot. The operation is repeated until each lot has had four treatments, when it is considered "made." The tea is then sorted in revolving cylinders made of wire work of different degrees of fineness. As the cylinders revolve, the tea in the top one works through the meshes, according to size, into the cylinder below it, and so on. The meshes determine the grades, which are known as broken orange pekoe, orange pekoe, broken pekoe, pekoe, pekoe souchong, and souchong, in the order of their value. More than half—perhaps sixty per cent—of the making will be souchong. Next come the weighing and packing. Four and a quarter pounds of green leaf are supposed to make a pound of "made" tea.

Early Alpine Climbing.—In prehistoric times, says Mr. W. M. Carney, the Alps were traversed by two or three trade roads, the most important being that along which the exchange in bronze and amber took place. Italy was invaded over more than one pass in early times. In the mediæval period the passes of the Alps were largely used by pilgrims, the Great St. Bernard being their favorite route. An interesting account is extant of the passage of this route in winter by Abbot Rudolf, of the Troad, in the year

1128. An itinerary of the way was drawn up about 1154 by Abbot Nicholas, of Thurgör, in Iceland. It was a kind of guidebook for pilgrims. The climbing of mountains has occurred sporadically from ancient times. Hadrian climbed Etna to see the sunrise. In the eleventh century an attempt was made to climb the Roche Melon, but the summit was not reached till 1358. Toward the end of the thirteenth century Peter III of Aragon climbed Canigon in the Pyrenees, and saw a dragon on the top. In 1339 Petrarch climbed Mont Ventoux, near Vaucluse, "to see what the top of a hill was like." Charles VIII of France sent one of his chamberlains up the wall-sided Mont Aiguille in 1492. Leonardo da Vinci's general scientific curiosity led him to pay attention to mountains, and he appears to have ascended some part of Monte Rosa to a point above the snow line. In the sixteenth century the study of mountains advanced considerably, and a group of regular mountaineers was almost formed at Zurich, but civil and religious troubles blighted their enterprise. Conrad Gesner and Josias Simler were their leaders. The former appears to have been infected with the regular mountaineering ardor of the modern sort. Simler published a valuable and interesting book about the Alps, in which he gave sound, practical advice to climbers. During the first half of the seventeenth century mountains were neglected. Dragons were still supposed to linger among them, and they were thought to be the homes of devils, against whom outpost chapels were built.

Peat-moss Atolls.—The attention of Mr. Conway Macmillan has been directed to examples of a peculiar and hitherto unrecorded peat-moss formation observed in some of the lakes of Minnesota. From their position in the middle of ponds of considerable size, he has named them sphagnum atolls. Ballard's atoll is situated in an almost circular pond about a hundred and fifty yards across, which is surrounded, except for a short distance on the west, where a channel has been cut between two low jutting bars. The atoll appears from the surrounding hills as a ring of green, conspicuous and sharply defined, about seventy-five feet in diameter, and having a uniform width of about ten feet. Another atoll, Anderson's atoll, is in a pond about fifty yards across, with high banks, and forms a ring within a foot or two of twenty yards in diameter and having a breadth of about twelve inches. Both atolls support a diversified vegetation, which is not alike on the two. This vegetation likewise differs from that of the pond outside and of the inner lagoon, and varies with the development and desiccation of the atoll. The origin of these formations is ascribed by the author to a season of gradual recession of the waters of the pond, when a loose turf was formed, lining the edges of the pond, followed by a season of comparatively rapid increase in area and level, when this surface became detached from the shore. The atolls then probably first appeared as annular floating bogs, separated from the shoreward turf as a result of the original zonal distribution of littoral plants and the rise of the waters, together with the favorable concurrence of a group of special and necessary conditions. Some of the apparent conditions of atoll formation are a definite maximum size and depth of the present pond; considerable height and regularity of the banks of the present pond (whereby the zone of vegetation is protected from violent winds); a regular and gentle slope of the pond bottom from shore to center; a definite original character of littoral vegetation when the pond was at a low level; a reduction within minimum limits of the lateral pressure and tension of winter ice; and a comparatively prompt anchoring of the atoll upon the bottom.

Dakota Climates.—The Dakotas are divided, according to Dr. D. W. Robinson, into two climatic regions by the range of hills and highlands known as the Missouri Divide. In the east divide country "many of the essential characteristics of an ideal health region are present. . . . Excessive cloud and dampness are not present beyond what is needed for successful agriculture. The air is rare, pure, and exhilarating. Diseases of an acute character are not extensively prevalent, and outbreaks of epidemic disease are rare and easy to control." The upper Missouri basin, which is about three hundred miles long, between a hundred and three hundred miles wide, and rises from twelve

hundred to sixteen hundred feet at the Missouri Valley to from eighteen hundred to three thousand feet at the brines, "is the sunland of Dakota. It is drier than the east divide country." Contrary to what might be expected in a latitude so far north, the winters are short. The season usually begins about the holidays; with the exception of a few disagreeable days that come with the late fall rains, the weather is usually delightful. At times in midwinter the thermometer registers much below zero. These days of low temperature invariably follow a fall of snow, and before the bright sunshine that is sure to come has tempered the dry, cutting atmosphere. A very notable feature of this climate to those who have never before spent the winter in Dakota is their ability to pursue their outdoor employments on the coldest days without unusual discomfort. A temperature that would render outdoor pursuits impossible in an air laden with moisture will in this dry, sunny air be almost unnoticeable. Storms are frequent, but not as a rule destructive or dangerous. Probably the most disagreeable feature of this season as well as of all seasons in the Missouri basin are the sudden and ofttimes extreme changes of temperature. But in the coldest weather the United States Signal reports show that the temperature is not so low by several degrees at Pierre or Bismarck on the Missouri River as in the same latitudes east of the Missouri divide. Spring begins early. The warmth and sunshine bring this season fully a month in advance of the damper localities in the same latitude and many miles south in the Mississippi. In summer the days are often warm, but rarely oppressive. The autumn is the most delightful season of the year, and the year usually passes away with it. The favorable features of Dakota for health-seekers are that it possesses the proper altitude; that it has a water supply of the very purest; that by far the largest number of days of all seasons are days of sunshine; that it has a dry, porous soil; that it can not for years be overcrowded; that severe and fatal diseases do not extensively prevail; and that it has plenty of advantages for industrial pursuits, thousands of acres of cheap productive land, and a place where the poor and the prospective invalid can found a permanent home. The disadvantages are, that there are present to a certain degree sudden and depressing atmospheric changes; and that it lacks a great variety of means for diversion, although hunting, fishing, horseback riding, and other sports can be followed almost daily.

Mind Cures.—Why, asks Dr. A. T. Schofield, of Friedenheim Hospital, are not the great therapeutic powers of the mind given their due place and prominence in medical treatment? "Does any practical medical man doubt these powers? Is he not aware of the ingredient 'faith' which, if added to his prescriptions, makes them often all-powerful for good? Does he not know the value of strongly asserting that the medicines will produce such and such effects as a powerful means of securing them? Has he never witnessed the therapeutic value through the mind of the dentist's waiting room in curing toothache, or of the consultant's spacious dining room and back numbers of Punch, combined with the physician's august presence in the consulting room? And has he not seen how much more efficacious the very same drugs have proved when prescribed in such solemn surroundings than in his own humbler environment and less august presence?" Among the most valuable instruments of mental therapeutics is the mantelpiece striking clock. Sir Dyce Duckworth insists upon the great efficacy, in cases of persistent vomiting, of giving the liquid food in teaspoonfuls every five minutes *by the clock*. Food thus given is more readily retained, and all the more so if the clock can be clearly observed by the patient himself from the bed. At the exact time the mind, acting through the brain, enables the stomach (perhaps by some inhibitory power over the vomiting center in the medulla) to retain the food. The clock has also proved to be valuable in labor in promoting regularity in the intervals between the pains, as well as in the appointment of the hours for nursing the child. Its real value in these, as in all cases, is truly scientific, and lies in its potent aid toward rapidly forming accurate psycho-physical habits or artificial reflexes in the brain. The clock is a strong aid to sleep by enabling a person to go to bed at exactly

the same hour every night; regularity in this matter is a powerful hypnotic.

Effects of Wind on Soil.—Investigations by M. J. A. Hensele show that when the wind bears in an acute angle upon the surface of a soil it produces a pressure of the air of the soil that increases with the speed of the wind and the increase of the angle of incidence. The excess of pressure diminishes as the strata grow deeper. The pressure determined by the wind increases with the grossness of the particles and as the structure is grumelous. The wind provokes a diminution of richness in carbonic acid of the air of the soil, which becomes greater with increase of velocity. It also increases the evaporation of water from the soil. Wind striking the ground at an angle occasions an evaporation of more unequal force than when it blows horizontally. Richness in moisture has much influence in retarding evaporation, while elevation of temperature quickens it. The wind has no direct influence on the capillary ascent of water in the soil, but only acts indirectly by favoring evaporation and thus provoking a movement of water toward the surface as long as there is much of it in the soil. The temperature of the soil is depressed by wind in proportion to its velocity and the magnitude of the angle of incidence.

Behavior of Different Trees to Lightning.—The resistance of different trees to the electric spark has been studied by M. Jonesco Dimitrie, who placed pieces of sapwood of beech and oak in the way of the spark of a Holtz electrical machine. The spark passed through the oak after one or two revolutions of the machine, while twelve or twenty revolutions were required to give it force enough to pass through the beech. Five revolutions were sufficient with black poplar and willow. Ssmilar results were obtained with heartwood. The presence of water had no influence on the resistance, but richness in fat was an important factor. "Starchy trees," poor in fat, like the oak, poplar, willow, maple, elm, and ash, opposed much less resistance to the spark than "fatty" trees, like the beech, chestnut, linden, and birch. The pine, which is rich in oil in winter and poor in it in summer, shows a corresponding difference in behavior toward the spark at those two seasons. In the "starchy" trees the living wood was harder to strike with the spark than the dead wood. The bark and foliage are poor conductors in all the trees, but this is of little importance as compared with the conducting power of the tree itself. These results are in harmony with what has been observed as to the relative frequency with which trees of these several species are struck by lightning. The author found also that station and soil affect the liability of trees to be struck. The vicinity of water augments the danger. Isolated trees seem more liable than those which are massed. All species of trees may be struck when the electric tension is high.

Speech Tones.—Attention is called by Alexander Melville Bell to the tones associated with speech as a subject deserving scientific investigation. These tones are generally spoken of as accents. "Thus we say of a stranger that he has a foreign accent; or we may define the peculiarity and say he has an Irish, a Scotch, a French, a German, a Western, or a Southern accent. He may or may not add to this some distinctive pronunciations affecting vowels or consonants; but independently of these he will use in his phrases and sentences a combination of tones—a tune—which alone would suffice to suggest the nationality of the speaker. All national speech has its characteristic tune. This is especially noticeable in dialects of the same language. We are but little cognizant of our own habitual tunes, but we are at once sensible of any marked deviation from them in the speech of others." The author devotes a very interesting paper, which he read before the Modern Language Association last December, to the analysis of these "speech tones." He especially discusses the tones of the Chinese language.

Bacteria in Butter-making.—In a bulletin of the Storrs Agricultural Experiment Station, Connecticut, on the Ripening of Cream by Artificial Bacteria Cultures, the chief object of the ripening of cream is shown to be to produce the butter aroma. This aroma, though very evanescent, con-

trols the price of the butter. The butter-maker owes the aroma to the bacteria, for by their growth the materials in the cream are decomposed, and the compounds are formed which produce the flavors and odors of high-quality butter. Different species of bacteria vary much as to the flavors which they produce, some giving rise to good, some to extra fine, and others to a very poor quality of butter. A majority of our common dairy species produce good but not the highest quality of butter. Heretofore the butter-maker has had no means of securing the best flavoring bacteria; but now the bacteriologist can isolate and obtain in pure cultures those species which produce the best-flavored butter, and can furnish them to the creameries to use as starters in cream ripening. This artificial ripening of cream promises much for the near future, but it has so far been applied on only a small scale.

NOTES.

THE third summer session of the School of Applied Ethics is to be held at Plymouth, Mass., July 12th to August 15th. A special feature will be the attention given to the labor question and allied subjects in each of the departments. In the Department of Economics the relation of economics to social progress will be discussed by leading economists from different universities. In the Department of Ethics and History of Religion various phases of the labor problem in the past and present will be considered by a large corps of able educators. The relation of various forms of educational activity to ethical and social progress will be considered at a conference of educators and teachers, August 5th to 11th, and opportunity will be afforded for free and full discussion.

A COMMITTEE has been formed in Paris, with M. Pasteur at its head, to raise funds for the erection of a monument to the memory of M. Charcot.

IN a lecture at the Royal Institution on the Electric Discharge through Gases, Prof. J. J. Thomson deduced from experiments the conclusion that the conductivity of gases at a certain degree of rarefaction is greater than that of any metal, and almost infinitely greater molecule for molecule. At a higher degree of rarefaction, however, conductivity is diminished, and in a perfect vacuum, as has been shown by some of Prof. Dewar's experiments, it is probable that the discharge would not pass at all. From another series of experiments it was inferred that electric currents will cross a high vacuum freely though they produce no glow to indicate the fact.

WHY man can not swim without having learned, while other animals can, is explained by Mr. Robinson in the Nineteenth Century. It is a question of atavism. When in great danger we make the defensive movements most familiar or instinctive to us. The first impulse of quadrupeds is to run away, and the movements of running sustain them in the water, while man, true to his simian ancestors, tries to catch hold of something, and pushes his arms up, with the sure result of himself going down.

A CURIOUS colloidal form of gold, soluble in water containing basic acetate of cerium, is described by Herr Schottlander. The solution is of a very intense reddish-violet color, turning to carmine red in dilute solutions. The color still remains distinct in a solution containing only $\frac{1}{600000}$ of gold. These solutions are obtained by precipitating a dilute solution of a salt of cerium mixed with gold, by means of a lye of potash or soda. The green precipitate obtained is then dissolved in warm dilute acetic acid. The acetate of soda then gives a violet-red precipitate containing all the gold in the liquor and a little basic acetate of cerium. On drying this precipitate an amorphous bronze-colored mass, soluble in water, is finally obtained.

THE French Museum of Natural History received, a few months ago, a specimen of that rarest of birds, the *Apteryx*. It was carefully kept in a warmed room and fed with expressly chosen and prepared meats, for it was not supposed it could thrive in a foreign climate and among strange associations. One day in October it was gone, and could not be found, though the whole *Jardin des Plantes* was searched for it, till early in March a dog smelled it out in one of the ventilating holes of a row of newly erected buildings, in the cellar of which it had endured cold and rain and snow through the winter, and lived on what it could pick up. Never had it been known to be in better condition.

ORCHID culture, as we know it, according to an article quoted in Garden and Forrest from the Orchid Review, did not exist till early in the last century, when, in 1731, a dried specimen of the species *Bletia verecunda* was sent to Peter Collinson from the Bahamas. Collinson sent the tubers to the garden of a Mr. Wager, where they were nursed during the winter, and produced flowers in the next summer. Two of our North American cypripediums were cultivated, perhaps, as early as 1737. At the end of the century there were cultivated in English gardens, besides several hardy species, orchids which had been brought home by travelers and naval and military officers from

the West Indies, China, and the Cape of Good Hope. Our beautiful little *Calopogon pulchellus* was introduced accidentally in some bog earth which had been taken over to England with some plants of *Dionea* for the botanist Curtis. His gardener noticed some small, toothlike, knobby roots in the soil and took care of them so that they flowered in the following summer. The first orchid was figured in 1790 from the strongest of these plants.

PHILIBERT COMMERSON, the eminent naturalist and botanist of Bougainville's scientific and exploring expedition, 1766–'69, wrote of Réaumur, the entomologist and author of the Réaumur thermometer scale: "Réaumur, the illustrious Réaumur, has just died from the effects of a fall which caused a suppuration of all the internal parts of his head. Thus the poor insects have become orphans for a long time, for we other Linnæists are nothing but cruel impalers; but Réaumur was their father, their *accoucheur*, their nurse, their interpreter, their all."

THE results of examinations of European statistics by M. Lagneau go to show that as among occupations consumption is most prevalent among persons whose callings expose them to dusts; and next among those whose work is sedentary; while persons living in the open air enjoy an almost complete immunity. From another point of view, consumption appears to increase in towns rapidly with the density of the population.

REMARKING upon a proposal to establish a psychological laboratory in England, similar to the institutions of the kind that exist "all over the Continent," the *Revue Scientifique* observes that there is only one such laboratory in France deserving the name, and that to find really important installations it is necessary to go to Germany or to the United States; and that the English in arranging their experimental establishment will have to draw their inspiration from these two countries.

THE Geographical Club of Philadelphia was formed in 1891, and its first stated meeting was held February 24, 1892, when the president, Prof. Angelo Heilprin, read an opening address on the Present Aspects of Geographical Study. Since then, till January, 1894, twelve stated meetings have been held at which important and interesting papers have been read. The club was incorporated in May, 1892. Its purpose is defined to be the advancement of the science of geography and of geographical studies and exploration, the recording of discoveries, the presentation of researches, and the accumulation of works on geography. Among the features of its history to this time are its association, through a contribution of funds, with the Peary Arctic Expedition of 1893, and the issue of the first number of its Bulletin, containing an address, by Mr. E. S. Balch, on Mountain Exploration.

THE English Society for the Protection of Birds aims at preventing the destruction of beautiful and useful birds by influencing public opinion, and, if possible, by promoting legislation. Mr. E. H. Bayley, M. P., the president, referred, in his address at the annual meeting of the society, to the wholesale catching and killing of birds for purposes of sale, or for so-called sport. As an example of abuse in sport, he instanced a case which had been brought under his notice of a man who went down to Devonshire from London, and in a short time destroyed all the kingfishers on a certain stream. The number of members of the society has increased in one year from 5,200 to 9,159.

OBITUARY NOTES.

PROF. GEORGE JOHN ROMANES, author of the work on Animal Intelligence in the International Scientific Series, of the books, Mental Evolution in Animals and in Man, and Jellyfish, Starfish, and Sea Urchins, and of other scientific essays and treatises, died suddenly at Oxford, England, May 23d. He was born in Kingston, Canada, in 1848, spent his boyhood in Europe, and was graduated in Natural Science at Cambridge in 1870. His first scientific writings of mark are a series of papers on the Nervous System of Medusæ. He was elected a Fellow of the Royal Society in 1879. He held the appointment of Fullerian Professor of Natural History in the Royal Institution, London, and Rosebery Lecturer on Natural History in the University of Edinburgh. He was a personal friend of Charles Darwin; and most of his writings were in development of Mr. Darwin's theories and the doctrine of evolution, or in criticism of them.

PROF. ROBERT PETER died at his home near Lexington, Ky., on the 27th of April, at the age of eighty-nine. He is well known among the older generation of scientific men for his chemical work in soil analyses in connection with the various geological surveys of Kentucky and Arkansas. He was a contemporary of many of the older men of science, and was for many years personally and officially associated with David Dale Owen in his geological work. He was the oldest medical professor in America, and occupied the chair of Chemistry in the Transylvania University in its earliest days. When that school was removed to Louisville and became the Kentucky School of Medicine, he went with it. At the time of his death he occupied, nominally, the chair of Chemistry in the Agricultural and Mechanical College at Lexington. He was a native of Cornwall, England, and was born in 1805.